

**DESIGNER, INTEGRATOR & OPERATOR  
OF MISSION CRITICAL SYSTEMS**



**CS AND THE NUCLEAR FIELD**



# The civil nuclear sector is a booming market with important risk issues at stake. To control the risks involved, CS capitalises on its know-how to provide the leading nuclear players with a global offer combining security, innovation and sustainability.

## CONSULTING AND ENGINEERING FOR THE NUCLEAR INDUSTRY

As engineering counterpart of nuclear installation designers and operators, CS provides high-tech services to improve the operability and safety of these installations covering their design, maintenance and decommissioning.

### SCIENTIFIC SOFTWARE ENGINEERING

► Development, renovation and maintenance of neutronics, thermo-hydraulics, mechanics, radiation protection, nuclear materials management etc. design codes for sustaining the scientific and technical assets of engineering services using proprietor codes.

► Setting up reusable and interoperable system component libraries for optimisation and reliability of operation and safety studies.

► Architecture and integration of high-performance simulation platforms for full and fast coverage of the design calculations indispensable for new plant construction programmes..

### STUDIES ENGINEERING

► Design, dimensioning, operation, fuel management and safety studies for reactors of different series.

► Thermo-hydraulics, neutronics, mechanics, and instrumentation & control studies.

► Radiation protection studies to minimise the radiation exposure received by application of the ALARA (As Low As Reasonably Achievable) principle.

► Drafting and assessment of the Basic Nuclear Installations safety regulations.

► Setting up of design offices close to the operators.

### TRAINING ENGINEERING

In collaboration with Universities or with utilities' job training departments:

► Drawing up training schemes for nuclear physics engineers.

► Training in design methodology and in the use of associated computing facilities

► Construction and operation of nuclear power plant operation and maintenance training centres.

### FACILITIES

► Infrastructures: CS boasts a virtual design office enabling its design engineers to access high-performance distributed computing facilities (TS2) in full security and to open up this access to its customers.

► Off-the-shelf software: CATIA, ENOVIA, PDMS, AUTOCAD, FLUENT, ANSYS

► Specific software: ASTER, TRIO-U, TRIPOLI, MCNP, APOLLO, CRO-NOS,

► Range of expertise: reactor physics, fuel cycle, safety, radiation protection, scientific computation, numerical simulation, project management.

► Standards: Knowledge of environmental standards ISO 14000; EN13480 (European Standard for industrial metal piping), EN10216, EN10217, EN10218 etc. (European materials standards), KTA 3702 (Diesel Generator Germany), RCCM, RCCE, RSEM, FEM etc.

► Electrical authorisations H1V B1V ES...



WITHIN THE SCOPE OF PLANT DECOMMISSIONING, CS PROVIDES A PACKAGE COMBINING ITS EXPERTISE IN THE FIELDS OF VIRTUAL REALITY, SIMULATION, CONFIGURATION CONTROL, ASSIGNMENT SCHEDULING AND FOLLOW-UP

# MANAGEMENT OF NUCLEAR MATERIALS

The up-turn of civil nuclear power in the world is accompanied by the necessity to master and adopt an extremely dependable safety policy.

The ability to design systems enabling safety analyses to be performed is one of the major issues involved in nuclear power development.

Furthermore, mastering risks assumes full traceability of nuclear materials. The main nuclear materials used by the industry are subject to checks at European level by the Euratom authority.

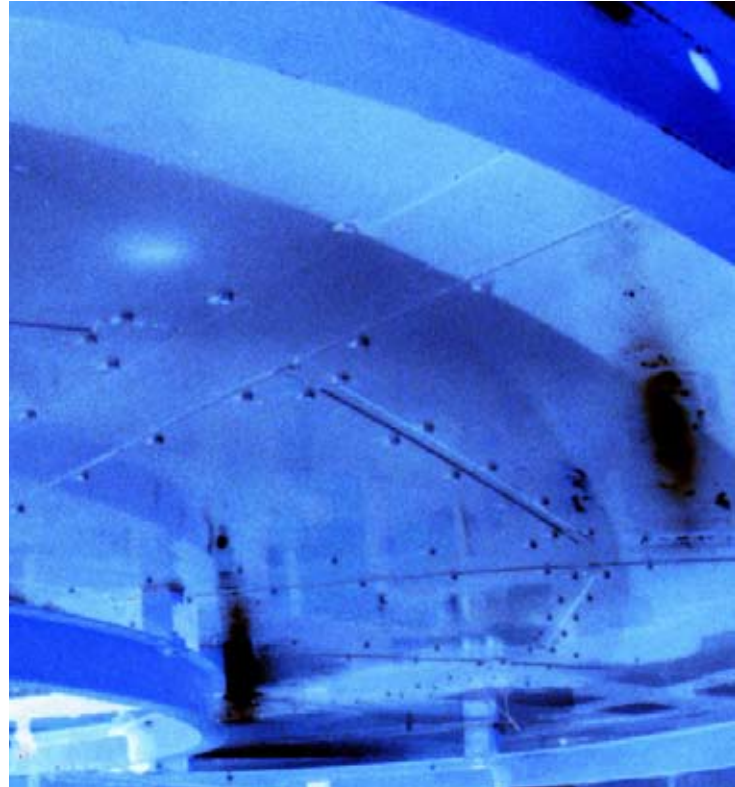
The purpose of these checks is to ensure that no State diverts nuclear materials.

At national level, France has also taken specific measures to protect the use of nuclear materials against malevolent acts thereby ensuring secu-

rity on its territory compelling operators to set up comprehensive checking and traceability measures for these nuclear materials.

Within this framework, CS has developed the CEA and IRSN nuclear materials management platforms, thereby contributing to total traceability and sustainability of data.

These systems enable all the movements and transformations to be tracked in accountable manner with an associated authorisation according to the players involved.



WITHIN THE SCOPE OF NUCLEAR RISK MANAGEMENT, CS IMPLEMENTS NUCLEAR MATERIALS MANAGEMENT PLATFORMS FOR THE RADIATION PROTECTION AND NUCLEAR SAFETY INSTITUTE (IRSN) & THE MILITARY APPLICATION DIVISION OF THE FRENCH ATOMIC ENERGY COMMISSION.



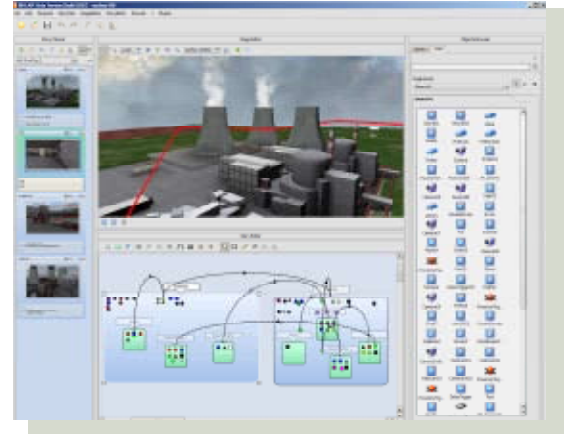
## TRAINING AND DESIGN SIMULATORS

With more than 20 years' experience in most of the nuclear plant series, CS offers a wide scope of services and solutions, ranging from... Combining knowledge of models with that of industrial processes, and using the best of the virtual reality technologies originating from...

### ► BASIC PRINCIPALES SIMULATOR

Based on a simplified representation of the installation, this type of simulator provides initiation in the operating principles of a nuclear power plant: reactor control, main control circuits, steam generator dynamics, turbo-generator set etc., and interaction of these different systems.

A teaching-gearred facility par excellence, this simulator provides internal variables display functions with high added value as far as learning is concerned. Simplicity of understanding and ease of maintenance make this simulator the ideal practical work facility for universities and training centres to enrich and complete the theoretical knowledge of their engineering students.



### ► FULL SCOPE SIMULATOR

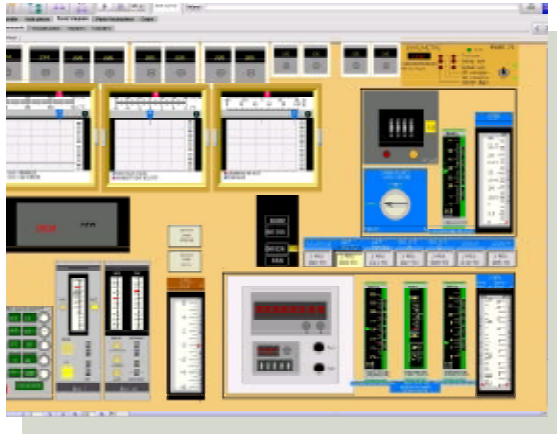
The full-scope simulator gives a detailed representation replicating the power plant equipment. A requirement of the safety authorities, it is the indispensable facility for training operators in control of the installation in normal, incident or accident operating conditions, a compulsory step in granting operating licences to operators.

Enriched with a virtual control room, it can become a design simulator for validating instrumentation and control systems or for testing new procedures. CS proposes Maintaining in Operational Condition and renovation of these simulators so as to upgrade them over the lifetime of the installations to guarantee their representativeness and prevent obsolescence of their components



# AR RISK MANAGEMENT

from design studies through to production of simulators.  
from the systems developed by CS for Defence and Aerospace.



## ► SPECIALISED SIMULATOR

With this facility, the operator focuses his learning on control of an important plant component such as the reactor, turbo-generator set etc., the others being controlled automatically. This allows him to gain in-depth insight into the fundamental behaviour of these components before training on the full-scope simulator, thereby optimising use of the latter.

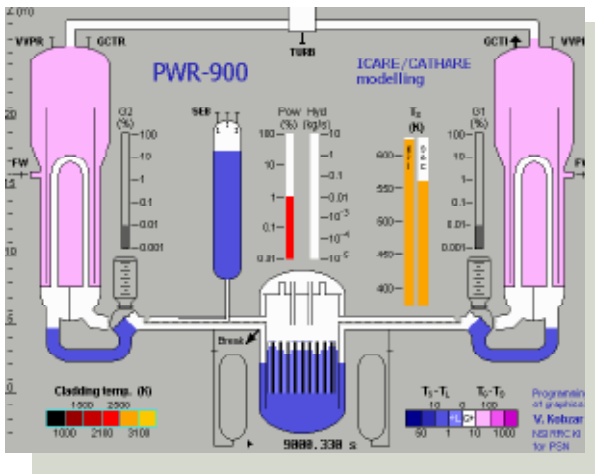
Possibly derived from the full-scope simulator, the process model of which is interfaced with a virtual control room, this simulator boasts innovating display and virtual operator functions enabling the operating scenarios adapted to the requirements of the trainers and trainees to be easily multiplied.

## ► DESIGN SIMULATOR

Based on full-scope simulator technologies, the design simulator provides nuclear engineering teams with a real-time simulation environment coupled with a virtual control room or with a specialised graphic interface for design offices. Flexible and fast to implement, this environment integrates cutting-edge neutronics and thermo-hydraulics simulation codes.

The choice of user interface depends on the purposes of the study:

- ✓ Studying operating and safety performances in normal and accident transient operating conditions.
- ✓ Study and validation of the instrumentation & control or of operating procedures.
- ✓ Study and validation of operating procedures.
- ✓ Post-analysis of operator actions in incident or accident operating conditions.
- ✓ Studying the events giving rise to these situations.



# CRISIS MANAGEMENT CENTRE

The crisis management systems combine ability to command and mastering of information.

These systems enable crises to be anticipated, and controlled, prepare for them to be overcome and provide experience feedback making for a progressive approach.

They take data collection and analysis, decision-making and decision dissemination into account.

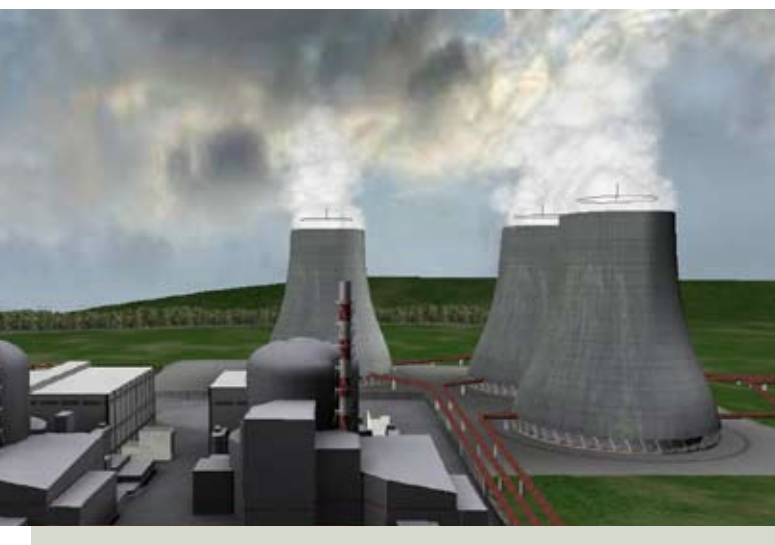
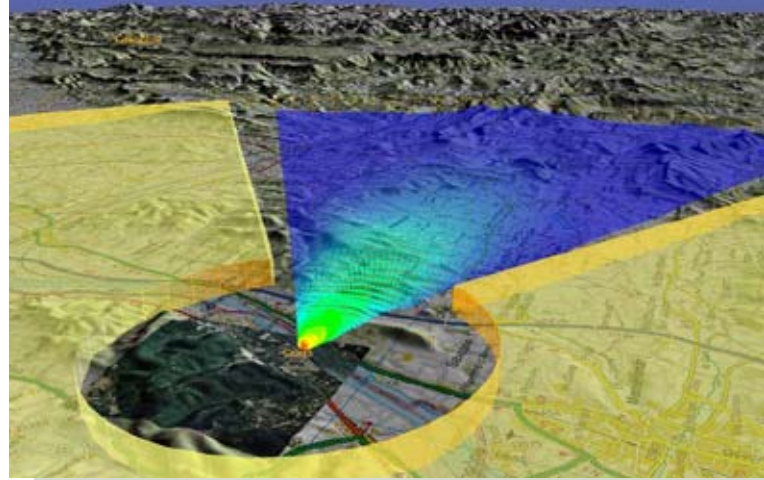
They cover the different phases of prevention, control and recovery, and provide homogeneous, integrated and consistent means for ensuring efficient and operational management during these three phases.

In the prevention phase and before the crisis, the system performs data acquisition and processing and provides the means for performing continuous contingency monitoring.

It also performs reference data control and monitoring of modifications to the latter.

In the crisis phase, the system makes use of efficient operational communication means whatever the circumstances; it provides resource management tools and prediction and tactical management means.

After the crisis, the system provides elements for assessing the consequences, diagnostics aids and assistance in returning to normal operation.



CS has designed an operational software package validated and implemented by crisis managers.

The system developed by CS is based on a set of functional models and tools covering all the phases of the crisis.

▶ Data acquisition management

✓ Suitable for widely varying data and acquisition modes.

✓ Data provided by sensors (NRBC, meteorological, etc.), from other data systems or from human observers taken into account in real time.

▶ Prevision and/or simulation models

✓ Scenario simulation, historical situation replay, validation of working assumptions.

✓ Modelling in virtual reality for behaviours for which no data is available.

▶ Alarm management

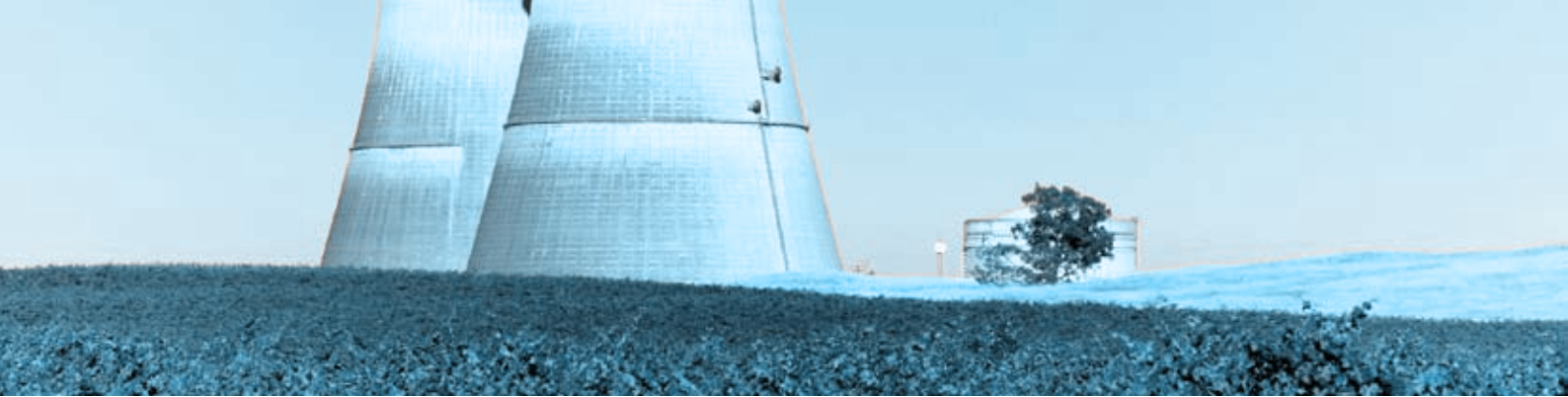
✓ Triggered according to thresholds, scenarios, alerts communicated from outside...

▶ Crisis scenario

✓ Decision-making aid for operating staff.

▶ Secured information dissemination

▶ Services for communication, data management and analysis, log management, and geographical functions.



## EXAMPLES OF OUR ACHIEVEMENTS

### ▶ EDF - CIPN

Renovation of the pool of specialised simulators that reproduce the main sub-systems of a PWR power plant. These simulators are used by EDF operators for training in control of important components of the plant (reactor, chemical and volume control system, turbo-generator set, etc.).

The purpose of this project was to replace the pool of part-task simulators scattered over EDF's nuclear power production sites and includes in particular industrialisation of the Mistral prototype (Mistral standing for Adaptable on-Line Real-Time Specialisable Interface Module).

### ▶ EDF - SEPTEN

Simulator configuration enabling safety analysis studies to be performed covering normal and accident operation of all EDF's PWR power plants, from the CPO series to the EPR. This mainly involved integration work on the new EDF SEPTEN simulation environment, SULTANE (standing for Software Sequence for Accident and Normal Transients in Studies).

These projects require in-depth knowledge of how a nuclear power plant functions.

### ▶ CEA

✓ Global contract over several years for performing maintenance of the reactor physics codes for the CEA.

✓ Running the Research and Technology Computing Centre (CCRT), applicative back-up, optimisation, paralleling of scientific codes on super-computer.

### ▶ IRSN

Development and maintenance of DPMA's severe accident simulation codes

### ▶ Industrial facility performance and reorganisation

**EDF R&D** : Industrialisation of the SALOME platform.

**GDF SUEZ** : Gas supply system optimisation and distribution.

**IRSN** : Component ageing study.

**IRSN & EDF** : EPR containment design with Cast3M.

**CEA** : Thermo-hydraulics code development and on-going applicative software maintenance.

**CEA DAM** : Participation in 3D simulation code development

**Hydroelectrica** : Development of SCADA instrumentation and control system.

**CEA DAM** : Quality control tool integration

**IRSN - CEA** : Nuclear materials accounting and management system.

**RTE** : Computerised vegetation management & on-going database maintenance.

### ▶ Safety, Protection and Environment

**IRSN** : Accidental release assessment.

**CEA - IRSN** : Dispersion of atmospheric discharges.

**Andra** : ALLIANCES platform software maintenance.

**ITER** : Back-up for setting-up the CATIA ENOVIA design environment for the ITER design engineering.

### ▶ Innovation and R&D :

As partner of Ter@tec, the European excellence centre for simulation and high performance computing created by the CEA, and at the heart of the SYSTEM@TIC collaborative R&D cluster, CS coordinates the EHPOC (High-Performance Environment for Optimisation and Design) project, following on from the IOLS (Software Infrastructures and Tools for Simulation) project. In partnership with the INRIA, CS runs the CILOE project for implementing a distributed intensive computing system for the partners of the MINALOGIC collaborative R&D cluster.

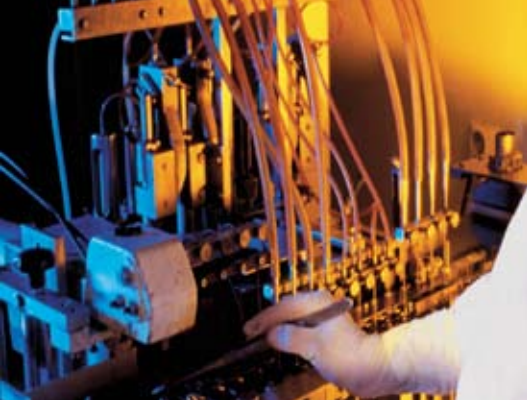
### ▶ Crisis management platforms & simulators :

Taking advantage of its experience in simulation, modelling and virtual reality, CS develops techno-operational simulation platforms.

✓ CRIMSON : crisis management simulation platform for emergency preparedness in urban environments.

✓ INSCAPE : interactive 3D scenario creation tool, the baseline for teaching and training simulators in particular in operating procedures.





## CS LOCATIONS WORLDWIDE

Main contractor for design and production of innovative high-performance turn-key systems, CS is involved at all levels in its customers' value chain.

With a turnover of 225 M€ and 2150 personnel, CS today rates as an established supplier acknowledged by its major customers for the expertise, commitment and sense of service of its staff.

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