

System safety

Reliability, Availability, Maintainability, Safety
-the RAMS-group at Department of Production and Quality Engineering

What is system safety and RAMS?



Photo: Harald Pettersen,
StatoilHydro

RAMS is an acronym for reliability, availability, maintainability, and safety - important quality attributes of all technical systems.

System safety is the systematic process of ensuring RAMS in a life cycle perspective.

RAMS is a central element in many different application areas, ranging from manufacturing, transport, and process industry, to nuclear and space industry.

In several universities, RAMS courses are integrated into study programmes in industrial and/or systems engineering. At NTNU, we have chosen to offer a dedicated 2-year MSc program in RAMS.

Reliability denotes a product or system's ability to perform a specific function and may be given as design reliability or operational reliability. The design reliability of a car is, for example, the ability the car has to function as intended when it leaves the factory. The operational reliability of the same car denotes its ability to function in operation - over its whole life or over a specified period.

Maintainability is a design property of a product or system and is determined by the ease at which the product or system can be repaired or maintained. The maintainability of a system depends, among other things, on the accessibility, the standardization, and the modularization of the system.

Availability denotes the ability of a system to be kept in a functioning state. The availability of a system depends on the system's design reliability, its maintainability, and its maintenance support.

Safety is also a system property. A system is said to have an adequate safety if it does not cause harm to people, the environment, or any other assets during its life cycle - during normal use and also for foreseeable misuse.

Many technical products and systems are combinations of software, electronics and mechanical components. Interactions between technical systems and our global society are becoming tighter and more interdependent, making system safety competence more important than ever.



Why study RAMS and system safety?



Photo: Øyvind Hagen,
StatoilHydro

The need for RAMS expertise in industry and authorities creates many different job opportunities.

Our RAMS MSc Program allows the students to specialize in different industries. Access to industry related projects is easy, as well as finding a job after graduation.

To attain the desired RAMS characteristics of a product or system, structured approaches are necessary:

- To quantitatively predict RAMS product and system performance to decide whether or not the performance is as good as desired.
- To systematically identify and remove undesirable RAMS characteristics.

Some industries, like the nuclear, space, and oil/gas industries, have focused on system safety for decades, but improvements are necessary to accommodate technology advances, new operational philosophies, and more demanding requirements for environmental protection. Other industries are only awakening to the need for RAMS; as they face warranty costs as high as 10 - 12% of their gross sales, devastating liability claims due to harm caused by their products, or when realizing the high costs of product recalls due to potentially harmful product characteristics.

Study program and courses

The MSc program in RAMS is open to students who have completed three years of a:

1. Bachelor Degree in Engineering
2. One of the basic study programs at NTNU in engineering
3. An engineering college ("ingeniørhøgskole") in Norway

All lectures and lecturing material are in English. Upon completing the program, you receive the title "Master of Science in Engineering - Program in Reliability, Availability, Maintainability, and Safety (RAMS)".

Students from abroad may, if desired, carry out their master theses in cooperation with industry or organizations in their home country.

Master courses:

- Safety and Reliability Analysis
- Risk Analysis
- Maintenance management
- RAMS Engineering and Management
- Quality and Risk Management in Project

PhD courses:

- Risk Influence Modeling and Risk Indicators
- Reliability of Safety-Critical Functions
- Maintenance Optimization

Other courses:

See <http://www.ntnu.no/ross/courses>

Application forms and more information:

<http://www.ntnu.no/studies/msrams>

What do we do?

We work with safety, reliability, risk analysis, maintainability management and RAMS engineering and management; generic and in industries, such as oil and gas, transportation, and renewable energy production.

Our main competence related to system safety is within reliability of safety instrumented systems, risk analysis, maintenance optimization and management, and RAMS in system and product development processes. System safety and RAMS are also connected to the environmental challenges of today. We work with reliability analyses of small technical components to system analyses of sustainability, in which safety is related to environmental issues and economics. In a PhD project, system analyses were used to improve sustainability in the Norwegian fishing fleet.

Reliability of safety-critical systems is important in accident prevention. Safety-critical functions are introduced to prevent, or stop the development of an accident, and may be implemented by technical systems, administrative controls and human efforts. Several international standards are related to design and evaluation of safety-critical functions. We have been working with reliability analyses

of safety instrumented systems (SIS) since the mid 1980s. A recent PhD project developed analytical tools and methods to be applied in the context of the international standard, IEC 61508. We are also involved in the *PDS*¹ forum, a cooperation between oil companies, engineering companies, consultants, vendors and researchers, with a special interest in SIS.

Risk analysis and management are important to identify and reduce risks. We collaborate with SINTEF through the ROSS Gemini centre in research projects addressing risk analysis in the oil and gas industry, in the renewable energy sector, in transportation, and within societal risk and security of critical infrastructures. Safety barriers and risk indicators are topics which have been addressed in several PhD projects, related to the oil and gas industry and aviation.

Risk based maintenance management includes all activities related to maintenance functions. We develop mathematical methods and models for maintenance optimization to reduce life cycle costs and accident risk. Maintenance optimization of railway tracks and deterioration and maintenance models for components in hydropower plants are two examples of research in the RAMS-group. Other application areas are related to offshore subsea installations and wind farms.

RAMS engineering and management is related to energy efficiency, renewable energy systems, qualification of new technology, and product reliability specification and performance.

More information: <http://www.ntnu.no/ross/areas>

¹ PDS is a Norwegian acronym for reliability of computerbased safety systems

Who are we?

The RAMS group at Department of Production and Quality Engineering, NTNU, consists of 2 Professors, 1 Associate Professor, 3 Adjunct Professors, Post Docs. and Ph.D. students.



***More information about the staff:
<http://www.ntnu.no/ross/rams>***

ROSS Gemini center

The ROSS Gemini Center has a general focus on prevention of accidents in technological systems that may cause harm to people, assets, and the environment. Furthermore, to provide systems that are cost optimal with respect to reliability and safety requirements. The prime focus is on causes of failures and accidents, and on system designs that may lead to more reliable and secure systems, with a multidisciplinary approach to technical, human, and organizational factors.

A strong competence within the area of reliability and safety has been built up at SINTEF and the Norwegian University of Science and Technology (NTNU) in parallel with the development of the Norwegian offshore oil and gas activities and telecommunication infrastructure. Reliability oriented research has been steadily increasing over the same period, and from 1985, information security has been a fast growing research and education area. Today, NTNU and SINTEF, offer more courses and have more research activities related to reliability and safety than any other university or research organization world-wide. SINTEF is the largest independent research organization in Scandinavia, with more than 2000 employees.

The research of the ROSS Gemini Centre covers a wide range of theoretical and applied research activities, where academic activities are combined with practical projects for industry.

ROSS is a Norwegian acronym for risk and vulnerability studies. Gemini means “twins”. A Gemini Centre is a joint research cooperation between NTNU and SINTEF in a field where competence, activities, and future potential are considered to be very high.

About NTNU

With 20,000 students studying a range of disciplines in seven different faculties, NTNU is alive with the intellectual energy of people pursuing their dreams.

The Norwegian University of Science and Technology (NTNU) is Norway's second largest university, founded in 1910. The university has contributed to academic achievements and discoveries that have shaped Norwegian society.

53 departments are spread out over seven major campuses, and graduate about 3,300 students every year, two-thirds of which are master's or PhD candidates. The school's more than 100 laboratory facilities are distributed among the different faculties and departments, and are an important part of the university's offerings. More information:
<http://www.ntnu.no>



Photo: Mentz Indergaard/NTNU Info

Being a student i Trondheim

NTNU is home to roughly 350 different student organizations, where you can meet people who are interested in everything from Amnesty International to telemark skiing. NTNUi, the student athletic organization, operates two sports centers with training facilities and courses.

Every other year, student volunteers organize two popular festivals: UKA , which is Norway's largest arts and music festival, and ISFiT, an internationally known student conferences. While UKA is recognized for attracting top international musicians along with a range of art exhibits, performances and its very own UKA revue, ISFiT, the International Student Festival in Trondheim, regularly attracts world leaders to address and inspire conference participants.



Photo: Bård Gimnes/NTNU Info

About Trondheim

Trondheim was Norway's first capital city, founded more than 1,000 years ago, in 997. Today, the city's cafes spill out onto cobblestone streets lined with colourful wooden buildings, while the twin towers and copper-clad spire of Europe's northernmost gothic cathedral frame the southern skyline. Trondheim has about 160 000 inhabitants.

More information:

<http://www.ntnu.no/about-trondheim>

More information?

RAMS-group

Department of Production and Quality Engineering, NTNU

S.P. Andersensv. 5, Valgrinda

NO 7491 Trondheim

Tel: +47 73593800

Contact information:

<http://www.ntnu.no/ross/rams>