



NTNU

Kunnskap for en bedre verden

The RAMS group

- Fragments of a history

- An egocentric and totally subjective view

This is not at all a complete history of the RAMS group but may, hopefully, give some pegs that a more complete history can be built on.

Each of you may launch *alternative facts* and rewrite the history in the spirit of comrade Stalin.

Marvin: 2017-03-17

The RAMS group, March 2017



Professor
Anne Barros
(DNV-GL
funded)



Adjunct professor
Bjørn Axel Gran
(Safetec funded)



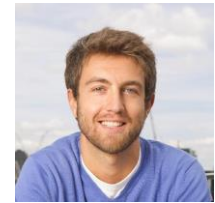
Associate
professor
Cecilia Haskins



Associate
professor
Yiliu Liu



Professor
Mary Ann
Lundteigen



Nicola Paltrinieri
[Onsager
fellowship]



Professor
Antoine
Rauzy



Associate
professor
Per
Schjøllberg



Professor
Jørn Vatn
(head of
group)

Temporary staff:

- Postdoc HyungJu Kim
- Scient.ass Andreas Marhaug
- PhD students (10+)
- Master students (25+/-)

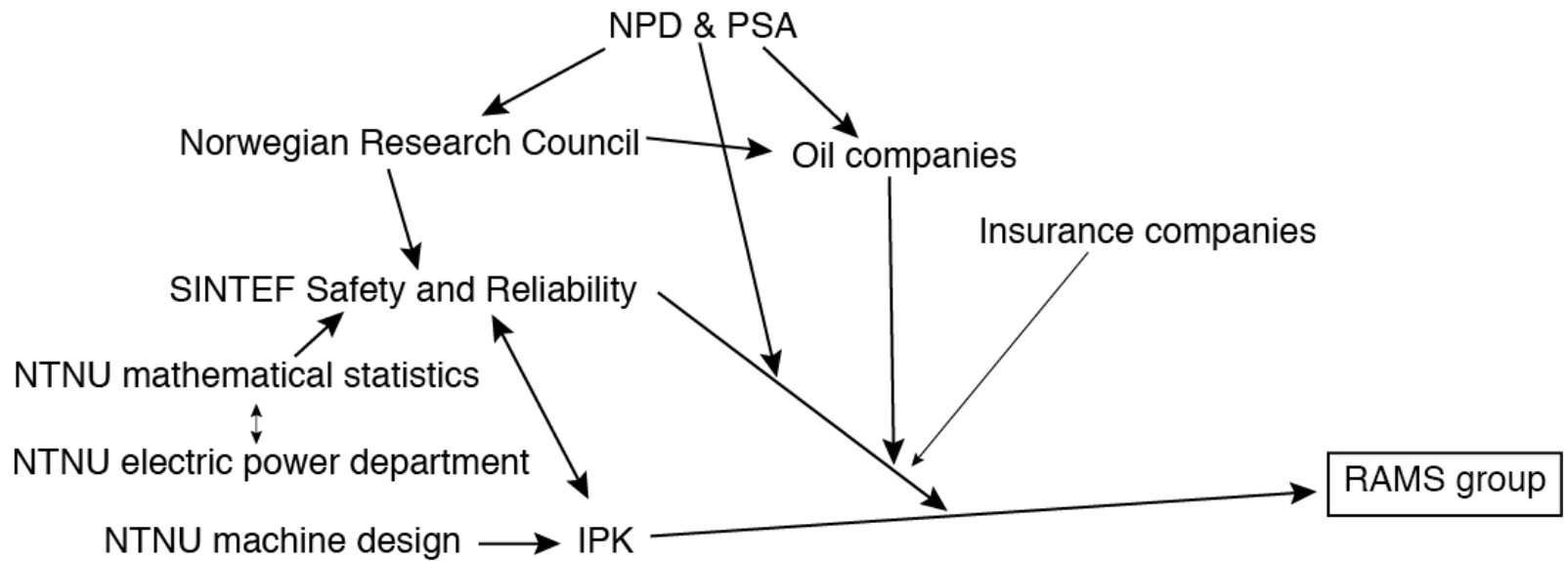


Professor
Marvin
Rausand
(retired)

My own background

- 1976-1979: Department of mathematical statistics, NTH -> NTNU
First some months as scientific assistant, then assistant professor.
- 1979-1989: SINTEF division of machine design -> division of safety and reliability
- 1989-2015: Professor, department of machine design -> IPK
- May 2015 -> : Retired and sometimes also tired

Influences



The fate of a RAMS engineer

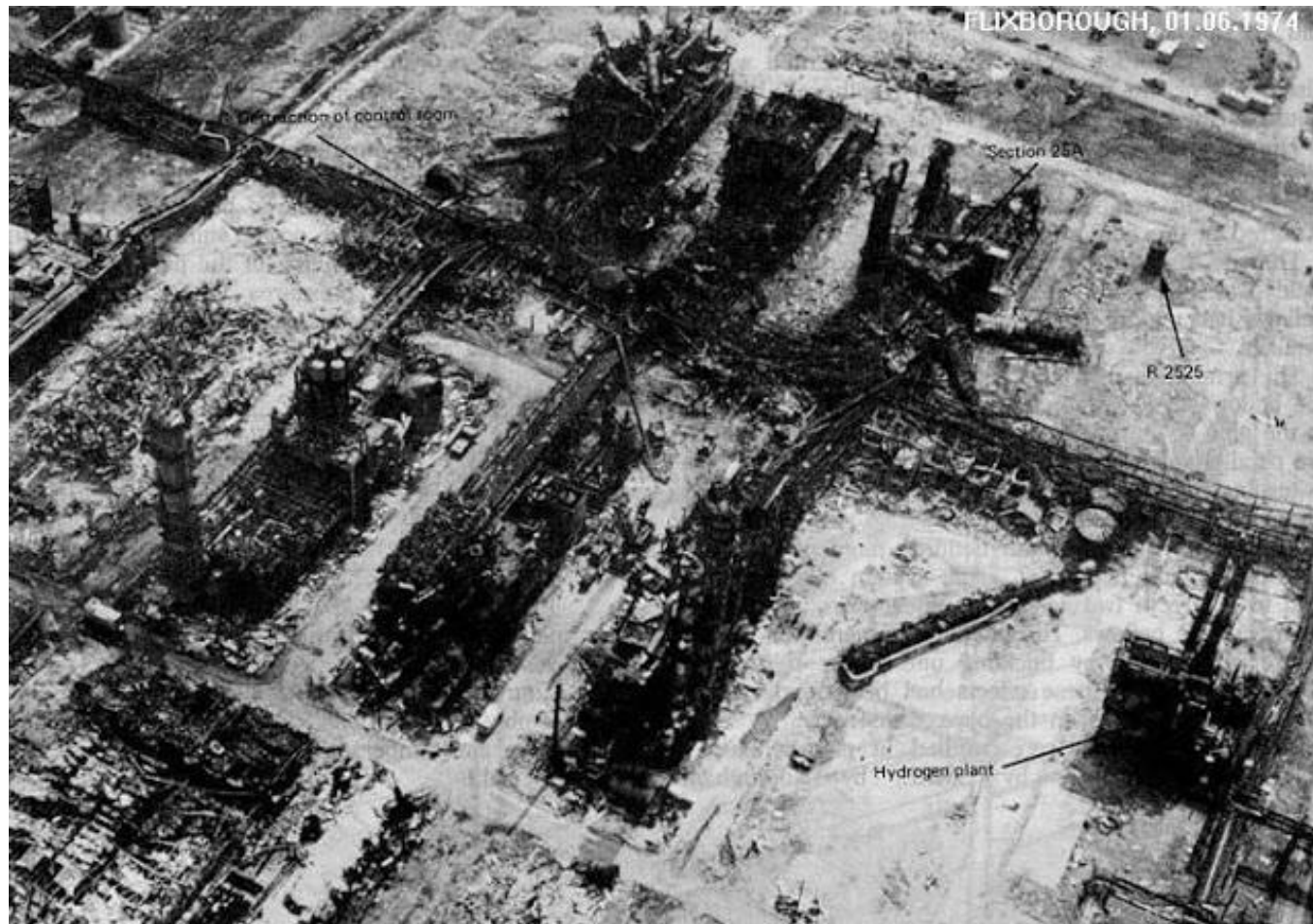
- She is doing everything correct → Operations run smooth and perfect → She is not noticed and gets no honor or fame
- An accident or major breakdown occurs → She is blamed and gets a lot of negative comments
- An accident occurs → Research organizations and universities get money to improve safety and reliability
- Accidents and major breakdowns have strongly influenced the development of the RAMS group

Flixborough – 1974-06-01



28 fatalities
36 badly injured
of totally 72 in the plant

Flixborough – the day after



Tretten railway accident – 1975-02-22



- 27 fatalities (including some high-profile politicians)
- 25 injured
- The train passed a stop signal (that should be red)
- Professor **Arne T. Holen**, NTNU was a member of the investigation committee

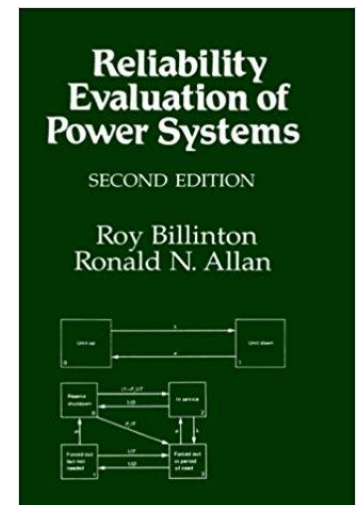


New activities at the electro-power department

- Professor [Arne T. Holen](#) started a new course in reliability of electric power systems (mainly based on the book by Roy Billington)
- Two PhD students worked under his supervision. One of these was [Stein B. Jensen](#).



Roy Billington (1935)
University of Saskatchewan, Canada

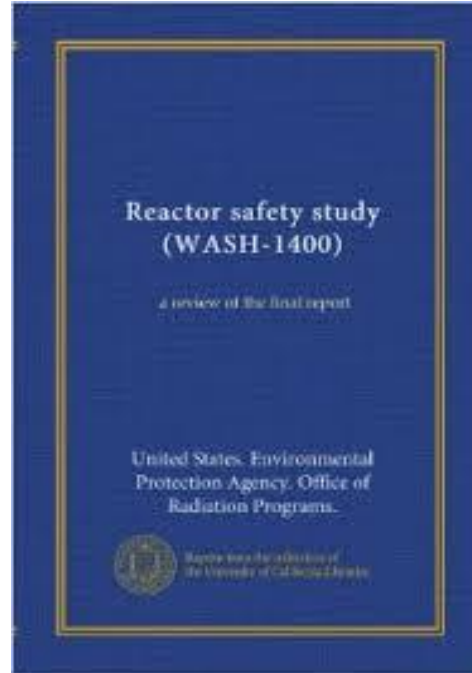


Stein Bjørnar Jensen

- The first head of SINTEF's safety and reliability activities
- Head of Statoil's subsea research activities
- Adjunct professor in risk analysis at NTNU
- Head of DNV GL's energy activities
- Now retired



Reactor Safety Study (WASH-1400) - 1975

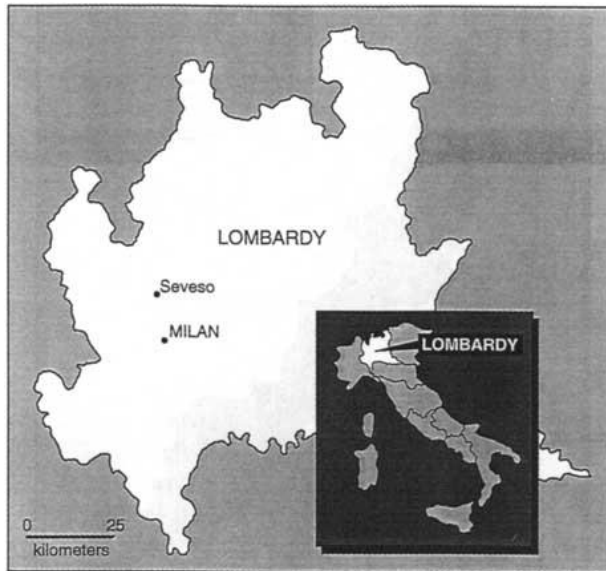


Also called NUREG 75/014 or the Rasmussen Report (after professor Norman Rasmussen, MIT, who was head of the investigation committee)

Reactor Safety Study

- The Reactor Safety Study is a seminal report and was written by very skilled experts. Among these were:
 - Norman Rasmussen
 - William Vesely
 - Jerry B. Fussell
 - And many more
- As part of this investigation, several new methods and new computer programs were developed:
 - MOCUS, KITT, IMPORTANCE, SAMPLE
 - The beta-factor model
- The Reactor Safety Study was strongly criticized by the [Lewis report](#) (1978)

Seveso (north of Milan) – 1976-07-10



Seveso-directive

- **Seveso I:** Directive 82/96 EEC: “Control of major accident hazards involving dangerous substances”
- **Seveso II:** Directive 96/82/EC
- **Seveso III:** Directive 2012/18/EU

Bravo Blowout – 1977-04-22

Ekofisk-field

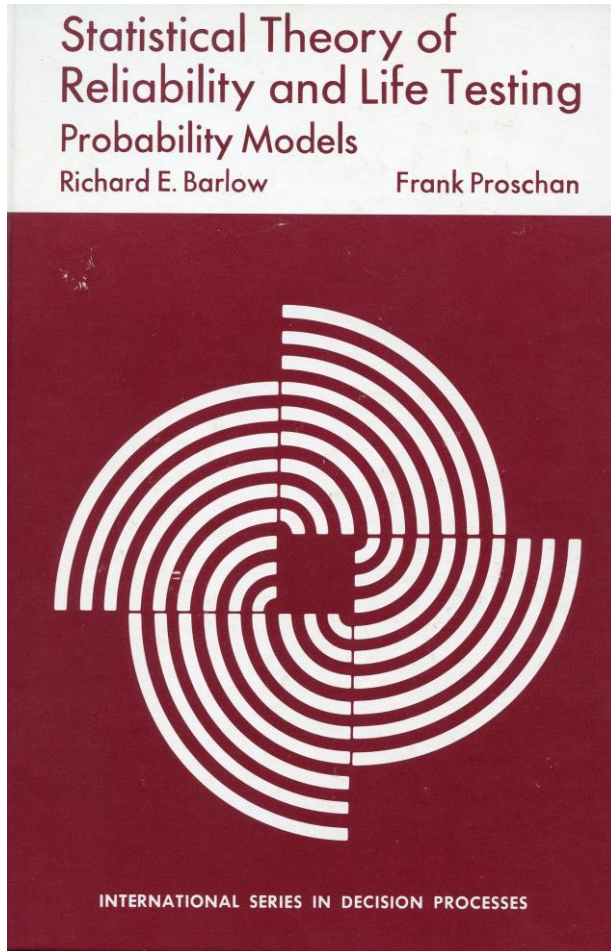


Professor Arnljot Høyland

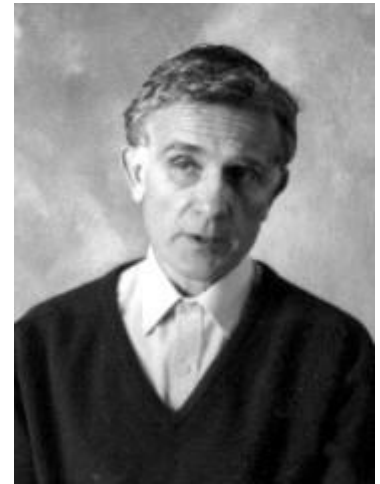


- Professor Arnljot Høyland (1924-2002)
- Head of the Department of Mathematical Statistics
- "Famous" for having composed the melody of the Christmas song "Julekveldsvisa"
- Sabbatical at the University of California, Berkeley 1975/76, where he met professor [Richard Barlow](#)
- Returned very enthusiastic and wanted to start a new course in reliability theory.

Barlow and Proschan - 1975

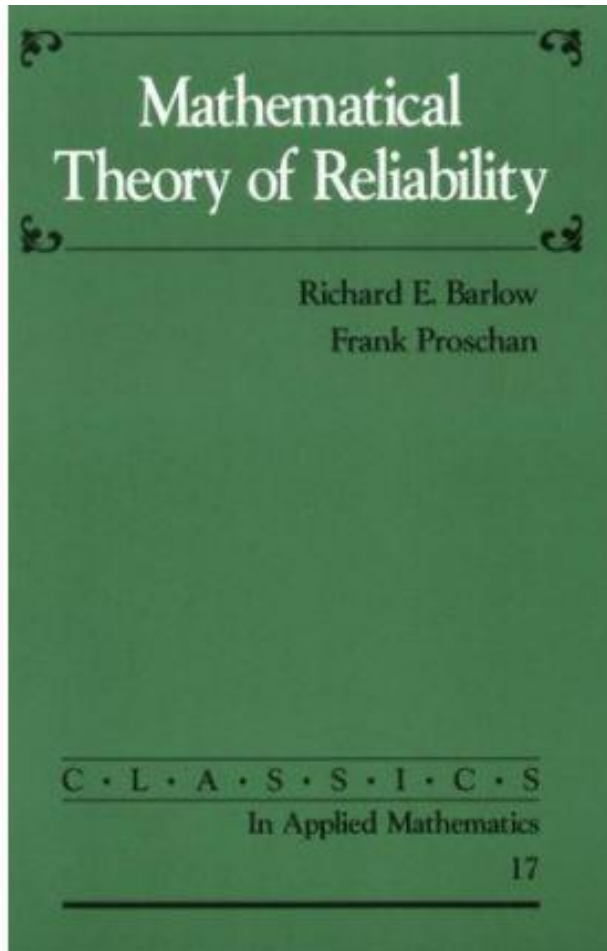


- Good book, but very theoretical
- Difficult to comprehend by NTH students
- Not suitable as a textbook at NTH/NTNU



Richard E. Barlow
(has visited NTNU
several times)

An earlier book by the same authors



1965

New course at NTH



- Based on Arnljot's enthusiasm
- Seminar during spring 1977 lead by assoc. prof. [Bent Natvig](#) (several participants)
- First course lectured during spring 1978 (lectured by me with assistance from Arnljot)
- Bent Natvig moved to the University of Oslo summer 1977 and has later lectured reliability courses there.

Professor Helge Christensen

- Helge Christensen initiated SINTEF's activities in terotechnology as part of the Machine Design division
- He stayed a period in USA and got interested in reliability engineering
- He got an adjunct professorship in terotechnology
- He took initiative to the course "Industriell sikkerhet og pålitelighet" – which is the fore-runner to TPK4120.
- This course was first lectured in 1979 by me (hired by Helge Christensen)
- Helge was appointed full professor in industrial safety and reliability at the Department of Machine Design in 1984 (?) but died some few years later.

Department of Marine Machinery

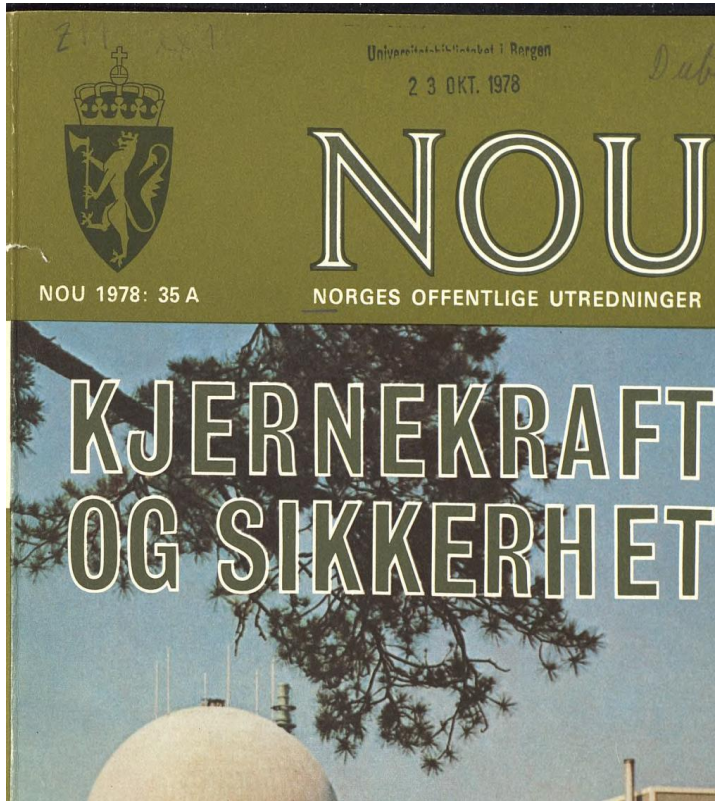
- Professor Knut Langseth initiated a course similar to “Industriell sikkerhet og pålitelighet” and asked me to lecture this course.
- The first course was offered in 1980 and it continued 5-6 years

Professor Torgeir Moan

- Professor in the Marine department of NTH/NTNU
- Started activities in structural reliability
- Also had some activities in system reliability



The Granli NOU report - 1978



- This NOU is a follow-up of the Reactor Safety Study
- Similar follow-up studies were conducted in several countries
- At that time it was a big discussion in Norway whether or not to build a nuclear power plant

SINTEF Safety and Reliability

- 1978: Established as a small subgroup of the terotechnology group, SINTEF Machine Design
- 1981: Established as a separate group of SINTEF Machine Design
- 1984: Established as a separate SINTEF division, called SINTEF Safety and Reliability



Stein B. Jensen



Roar Andersen



Tor Ulleberg



Lars Bodsberg

United Kingdom Atomic Energy Authority

- UKAEA actively promoted safety and reliability in the 1970s
- We were associated to UKAEA, participated in meetings, and got received relevant publications
- Here, we met people such as:
 - Ian Watson
 - T. R. (Bob) Moss
 - R. A. Humphreys

Professor Jan Hovden



- Born 1943
- 1973-1978: Assistant professor at NTH
- Joined the RAMS group in mid 1979
- Mainly worked within safety management
- 1986: adjunct professor in safety management at NTH, paid by Conoco
- 1991: Professor in safety management at the Department of industrial economics and technology management, NTNU
- 2013: Retired

Jan Hovden was a highly valued member of SINTEF Safety and Reliability in the period 1979-1991 – and afterwards as an advisor.

Safety Offshore (ca 1978->)

- Comprehensive research program that covered many safety and reliability issues
- Initiated as a consequence of the **Bravo blowout**
- Partly financed by the oil companies – as a requirement to get licence to operate an oil field
- Was very important for the SINTEF activities in safety and reliability:
 - Downhole safety valves
 - Subsea BOP systems
 - Production assurance studies
 - Well barrier studies
 - etc

Three Mile Island – 1979-03-29

Pennsylvania, USA



Alexander L. Kielland flotel



Alexander L. Kielland platform (right)

Alexander L. Kielland accident – 1980-03-27



Alexander L. Kielland - Investigation

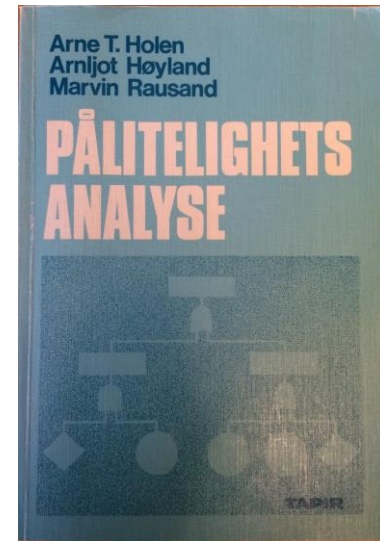
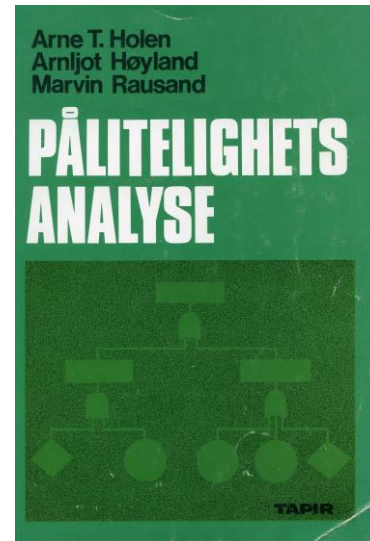
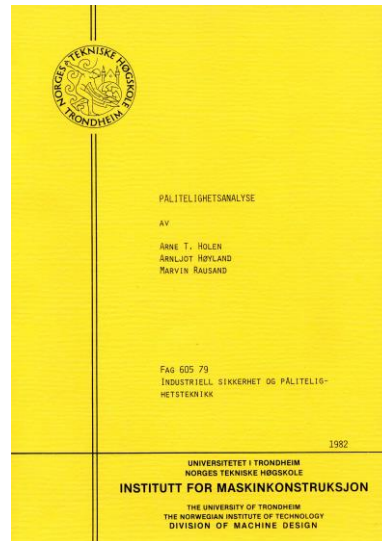
- The investigation resulted in the NOU: “Alexander L. Kielland –ulykken” (1981) – in Norwegian.
- Professor Torgeir Moan, Marine department, NTNU was a member of the investigation team.
- A high number of scientific papers have been published related to the accident

Textbook in Norwegian

Our first reliability textbook in Norwegian was published by Tapir forlag in 1983

Written by:

- Arne Holen
- Arnljot Høyland
- Marvin Rausand



The book was a great success, was reprinted several times, and was also used in Sweden and Denmark.

Bhopal – 1984-12-02



Sikkerhetsdagene – 1985---



- Vesta
- Conoco
- Phillips Petroleum

Sandoz fire – 1986-11-01

Basel i Sveits



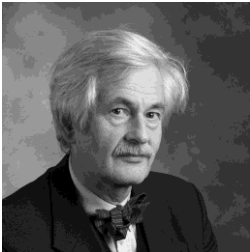
Herald of Free Enterprise – 1987-03-06

Zeebrugge, Belgium



193 fatalities (would have been much more in deeper waters)

Investigation of Herald of Free Enterprise



Willem Albert Wagenaar, University of Leiden



James Reason, University of Manchester

P. T. W. Hudson, University of Leiden

Jop Groeneweg, University of Leiden. The main developer of the TRIPOD method

Piper Alpha – 1988-07-06

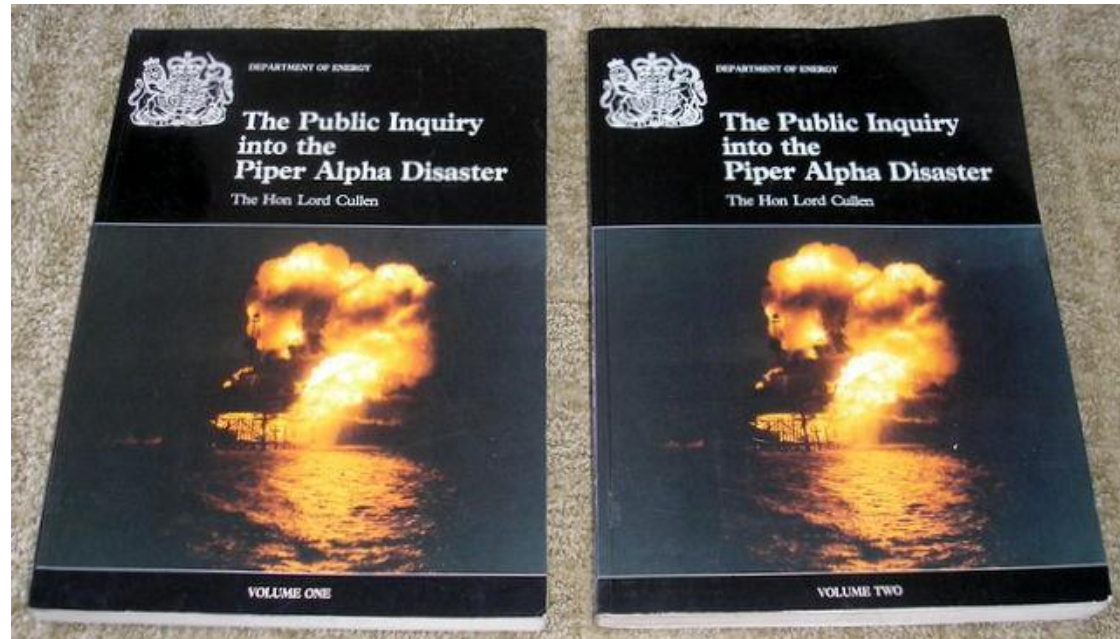
British sector of the North Sea



The Lord Cullen inquiry



William Douglas Cullen
Baron Cullen of Whitekirk, Scotland

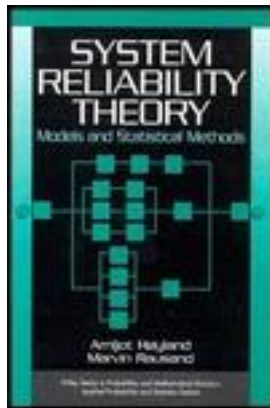


Scandinavian Star fire – 1990-04-07

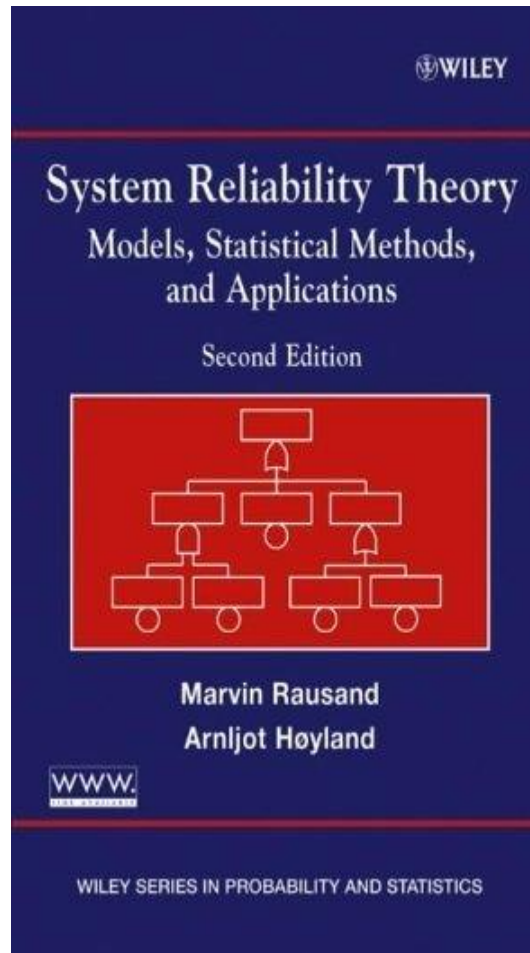
- A fire broke out on a cruise from Oslo to Fredrikshavn in Denmark
- A comprehensive investigation report was issued in the form of an NOU
- Several persons from NTNU were active in this work
- 159 fatalities
- There is still an ongoing discussion whether or not the fire was caused by arson (see wikipedia for more details)



New reliability textbook- 1994



1994



2004

A 3rd edition is
in the pipeline

Estonia ferry accident – 1994-09-28



The cruise ferry capsized in bad weather conditions just after midnight on its route from Tallin to Stockholm

Eschede – 1998-06-03

Germany



Åsta railway accident – 2000-01-04

Two trains collided near the station Åsta on the track from Hamar to Trondheim (via Røros) – 19 fatalities



Toulouse AZF – 2001-09-21



29 fatalities, 2500 injured

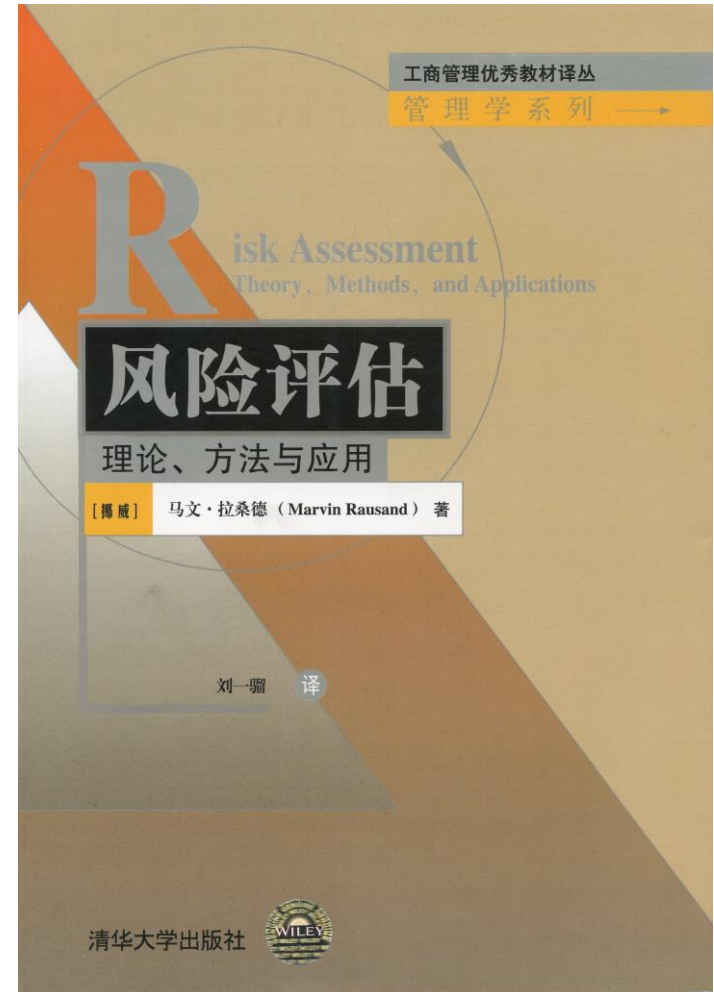
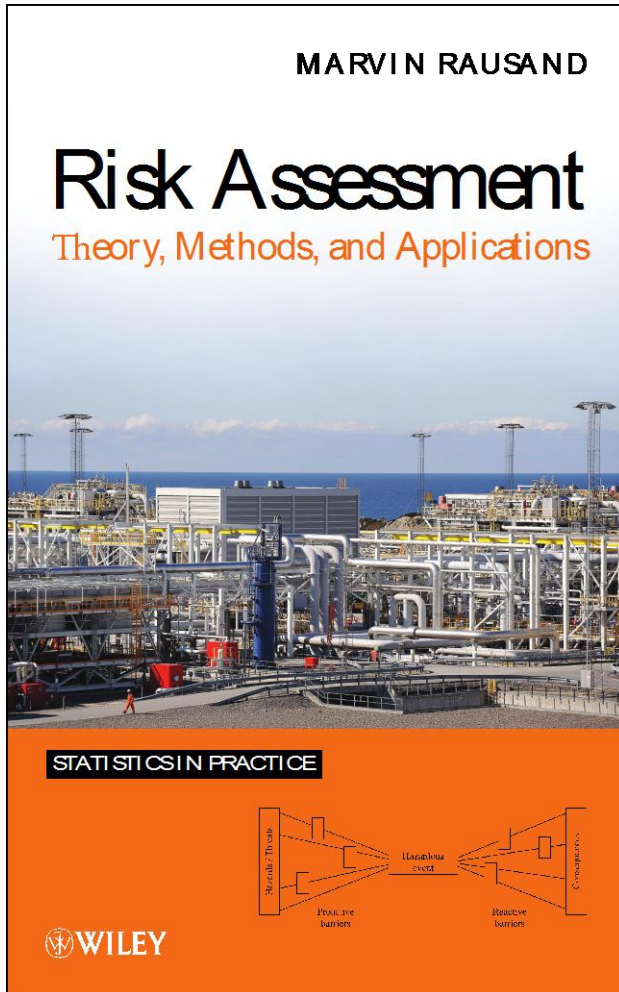
Deepsea Horizon – 2010-04-20

Gulf of Mexico



11 fatalities
The largest oil spill in our history

New book - 2011



New book - 2014

