An application of a SSMS model to the analysis of accidents

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Outline

- Accidents
  - Paddington accident (5th October 1999)
  - Piper Alpha disaster (6th July 1988)
- A SSMS model
- The Paddington & the SSMS model
- Piper Alpha & the SSMS model
- Conclusions & Future work

The Paddington railway accident

- On 5th October 1999 the Thames train (‘The Turbo’) was in collision with a FGW high speed train (HST), 2 miles outside Paddington, (London) railway station.
- The Turbo’s journey started at Paddington and it passed the red signal (SN109) and collided with a HST.
- As a result of the collision & the subsequent fires 31 people died and 227 were injured.

Piper Alpha platform & Piper field

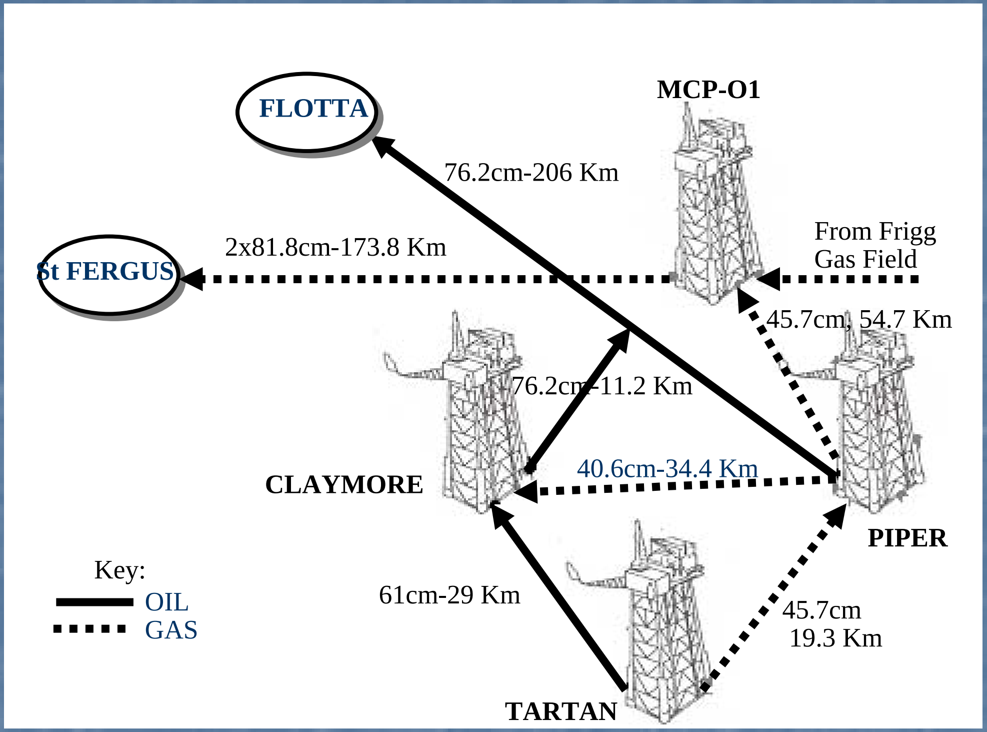
Piper Alpha platform

- Piper Alpha was located 110 miles north-east of Aberdeen, Scotland, UK.
- The platform provided the facilities to drill wells to the producing reservoir and extract, separate and process the reservoir fluids (a mixture of oil, gas and water).
- The production deck was located at 25.6 m above mean sea level and consisted of 4 production modules, A-D modules.
- **A Module** contained the wellheads & It was located at the south end of the platform. The wellheads, or “Christmas trees” of which there were 36, arranged in 3 rows of 12 each.
- **B Module** the production separators. It contained 2 main production separators, vessels in which the gas and water were separated from the oil.
- **C module** the gas compression plant. It contained 3 centrifugal compressors & 2 reciprocating compressors.
- **D Module** the electrical plant and various facilities. It was located at the north end of the platform and was essentially the power generation module.

Piper field

- Piper Alpha platform was linked by pipelines to 3 other platforms: **Claymore**, **Tartan** & **MCP-01**.
- **Claymore** was located at some 34 Km from Piper. It is a production platform and exported oil and imported gas from Piper.
- **Tartan** was located 19.3 Km from Piper and 19 Km from Claymore. Tartan was a production platform & produced both oil & gas for export.
- **MCP-01** platform was located some 54.7 km from Piper. It was a manifold compression platform (MCP). It received gas from the Frigg field & compress it and transmit it to the gas terminal -St Fergus.
- The oil from Piper, Claymore and Tartan was pumped to Flotta oil terminal, Scotland, UK.
- The function of the terminal was to separate from the oil: water, condensate and methane-gas.

Piper field



FLOTTA
MCP-O1
76.2cm-206 Km
From Frigg
Gas Field
2x81.8cm-173.8 Km
St FERGUS
45.7cm, 54.7 Km
76.2cm-11.2 Km
40.6cm-34.4 Km
CLAYMORE
PIPER
Key:
OIL
GAS
61cm-29 Km
45.7cm
19.3 Km
TARTAN

Piper Alpha disaster

- The accident occurred on 6th July 1988 and claimed 165 lives.
- It is believed that there was a leakage of gas condensate which was ignited causing an explosion which led to several large fires.
- At about 22:00 hrs an initial explosion occurred on the production deck of Piper
- At about 22:20 hrs there was a major explosion due to the rupture of Tartan gas riser.
- 22:50 hrs explosion occurred – rupture of the MCP01 gas riser.
- 23:20 hrs major explosion occurred – rupture of the Claymore gas riser.
- Between 23:30 – 00:45 hrs the centre of the platform collapsed, the risers from the gas pipelines and the MOL were torn apart

A SSMS Model

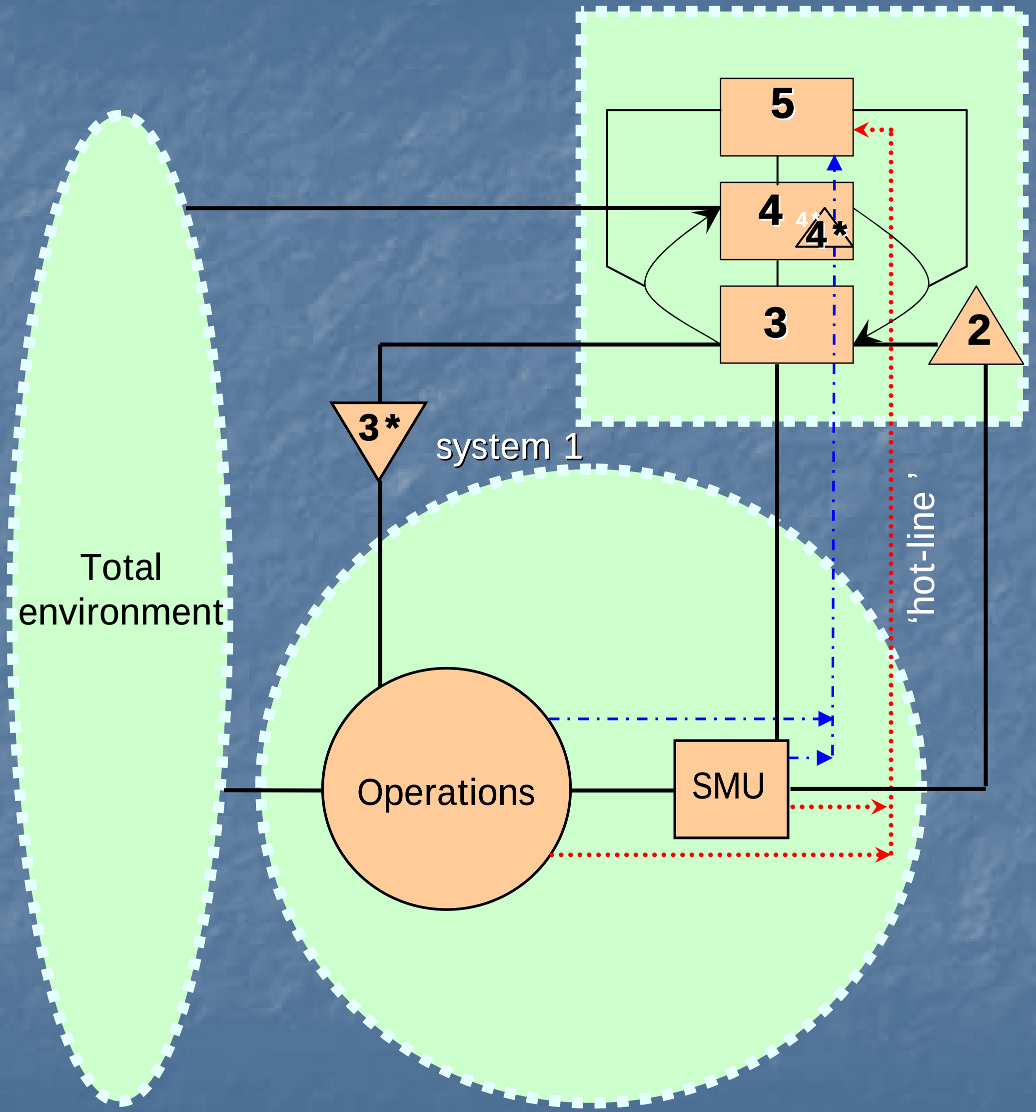
- The Systemic Safety Management System (SSMS) model is intended to maintain risk within an acceptable range in an organization's operations in a coherent way.

- It has a fundamentally *preventive* potentiality in that if all the sub-systems and channels of communication are present and working effectively the probability of a failure should be less than otherwise.

Fundamental characteristics of the SSMS

- **A structural organization which consists of a ‘basic unit’ in which it is necessary to achieve five functions associated with systems 1 to 5:**
  - System 1: safety policy implementation
  - System 2: safety coordination
  - System 3: safety functional (Monitoring, Assessment)
  - System 3*: safety audit
  - System 4: safety development
  - Safety 4*: safety confidential reporting
  - Safety 5: safety policy
- **A recursive structure (i.e. ‘layered’) and ‘relative autonomy’**
- **The SSMS and Its ‘Environment’**
- **Concepts of *Viability*, MRA (Maximum Risk Acceptable) and acceptable range of risk**
- **Four organizational principles**
- **‘Paradigms’ are intended to act as ‘templates’ giving essential features for ‘human factors’ and for effective communication & control.**

Structural organization of the SSMS



Components of system 1:

The square box deals with all the managerial activity needed to run the operations and implements the safety policy of the organization.

It monitors on a continuous basis the level of risk in the operations.

The circle encloses all the relevant operations or activities that take place to produce products or services.

It should be monitored because it is here where risks are created.

Structural organization of the SSMS

System 1: safety policy implementation, consists of various operations of an organization in which the organization's safety policy must be implemented.

System 2: safety co-ordination, ensures that the various operations of system 1 operate in agreement.

System 3: safety functional, ensures that system 1 implements the organization's safety policies.

System 3*: safety audit, is part of system 3 and it is concerned with safety sporadic audit.

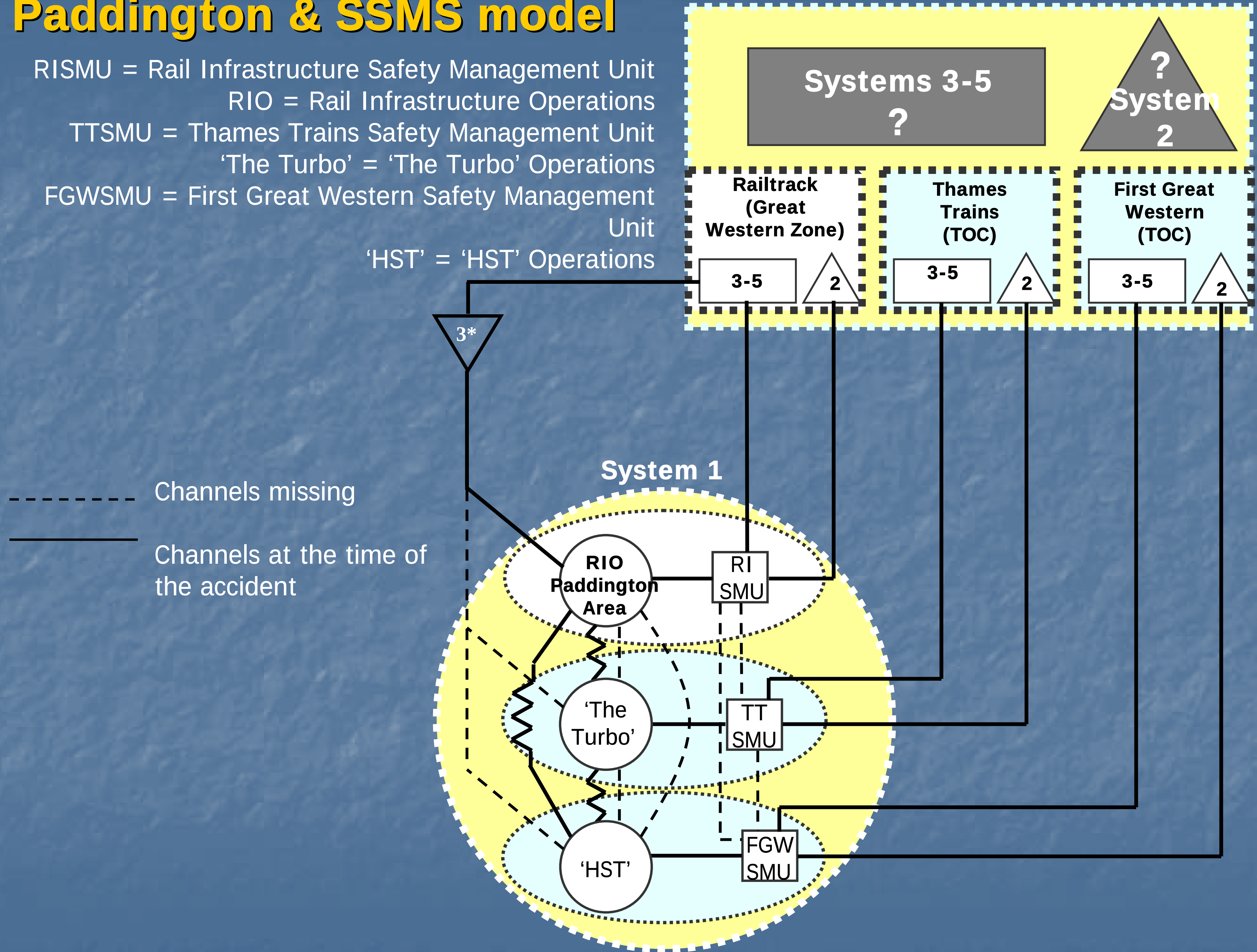
System 4: safety development, is responsible for identifying strengths, weaknesses, threats, and opportunities that can suggest systemic changes to the organization's safety policies.

System 4*: confidential report, is part of system 4 and it is concerned with confidential reports or causes of concern that may require direct and immediate intervention of the corporate management.

System 5: safety policy, is responsible for establishing safety policies for the whole organization.

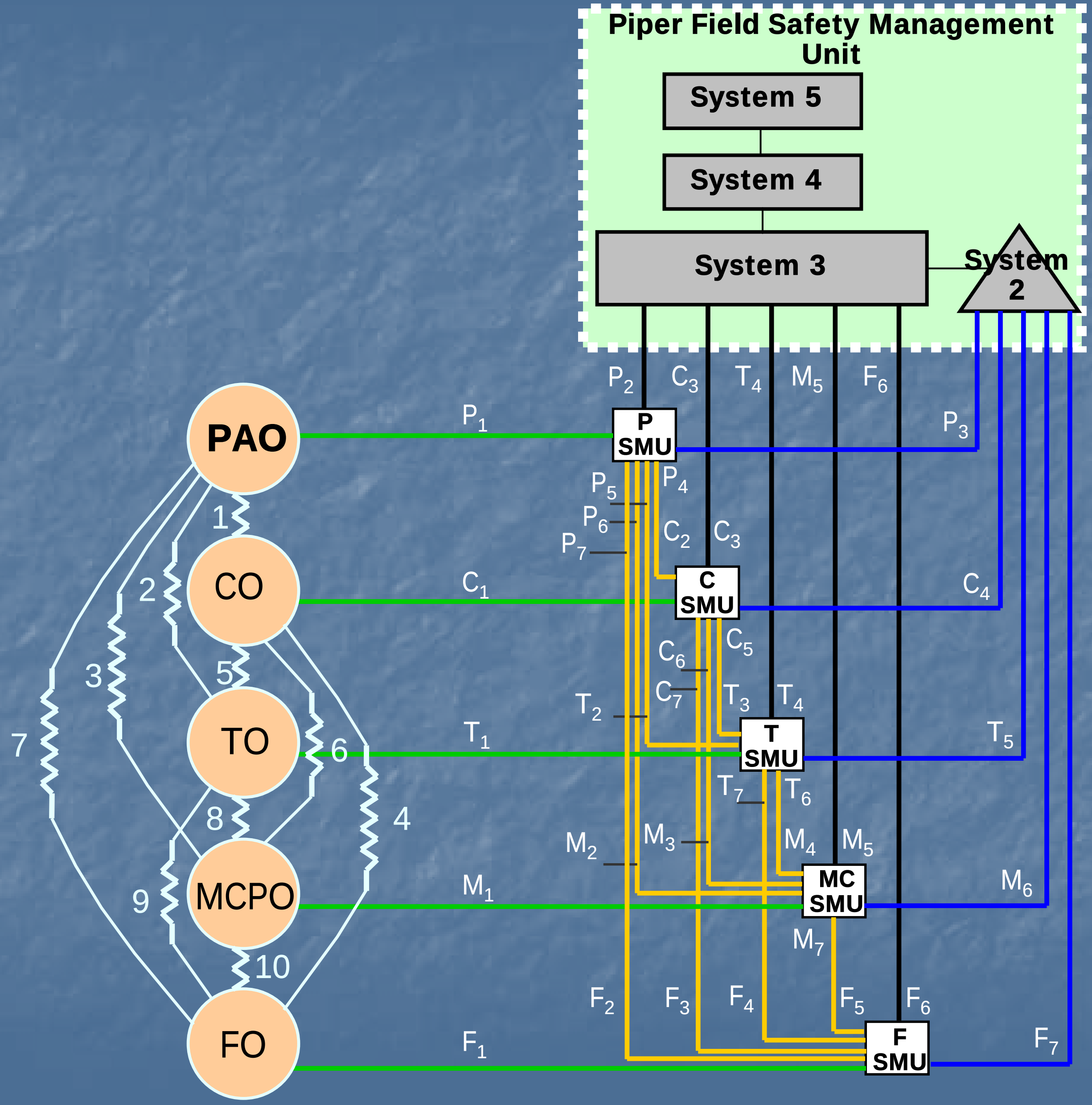
Paddington & SSMS model

RISMU = Rail Infrastructure Safety Management Unit
RIO = Rail Infrastructure Operations
TTSMU = Thames Trains Safety Management Unit
'The Turbo' = 'The Turbo' Operations
FGWSMU = First Great Western Safety Management Unit
'HST' = 'HST' Operations



Some findings
The fragmentation of the railway industry after privatization led to conflicts amongst the many organizations involved in the ‘train’ and ‘track’ operations. For example, Railtrack (RISMU), the infrastructure controller was charged with the continuous monitoring of the train movements without intervening directly in the management of the TOCs (Train Operating Companies).
There were no channels of communication between the TSMU and the RISMU.
There is a need of a system able to give ‘horizontal’ coherence among the organizations involved in the running of the railway system at every level of recursion at the time of the accident. The interaction between ‘train’ and ‘track’ should be coordinated effectively on a daily basis (see Fig. 3).
In general, there was no mechanism of coordination among the parts involved in the railway operations.

Recursion 1: Piper field – format of SSMS



'White' - Operational Inter-dependence

- Strong physical inter-dependence: e.g. "2" represents the gas pipeline connecting Piper & Tartan

'Green' - SMUs & their Operations

'Yellow' – Inter-dependence amongst SMUs

'Blue' - SMUs & System 2

'Black' - SMUs & System 3

Recursion 2: Piper Alpha – format SSMS

A-Module – contained the Wellheads
B-Module – production separators
C-Module – gas compression plant
D-Module – Electrical plant

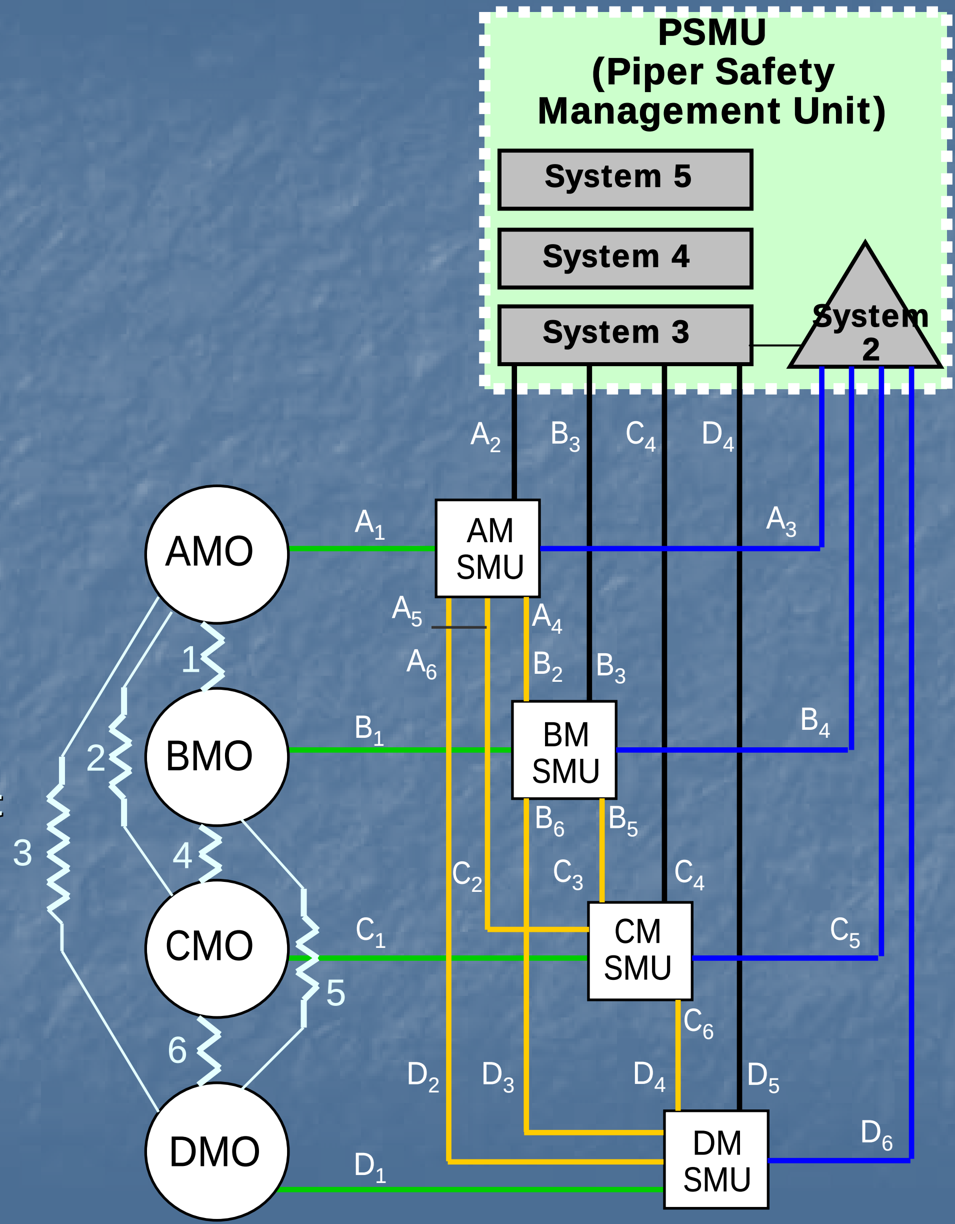
'White' - Operational Interdependence

'Green' - SMUs & their Operations

'Yellow' – Inter-dependence amongst SMUs

'Blue' - SMUs & System 2

'Black' - SMUs & System 3



5. Conclusions & Future work

- The SSMS can be used to analyze past failures.
- Further analysis of Piper Alpha disaster:
  - A detailed analysis of recursions 1 (i.e. level of Piper field) & 2 (i.e. level Piper Alpha platform).
  - Investigate whether anything could have been done at recursion 1 in order to prevent or defer the successive rupturing of the gas pipelines connecting Piper Alpha with Tartan, MCP-01 & Claymore.
  - The above should help to highlight the performance, or lack of it, of the functions associated with systems 1-5 at these levels of recursion.