

17th INTERNATIONAL CONFERENCE & EXHIBITION ON LIQUEFIED NATURAL GAS (LNG 17)



LNG INCIDENT IDENTIFICATION UPDATED COMPILATION AND ANALYSIS BY THE INTERNATIONAL GROUP OF LNG IMPORTERS (GIIGNL)

By: Anthony Acton, ActOn LNG Consulting,
Deborah Brown, GL Noble Denton and
Pierre Langry, Dunkerque LNG

April 17, 2013

International Organizers



Host Association



Legal Notice



The information presented here represents the outcome of a significant study undertaken by a group of LNG Importing Companies over the past twenty years. The information is intended to be useful for the LNG Industry to help to improve design and operations and is provided in good faith. However, GIIGNL, any of its members and the authors of this presentation and the paper on which it is based disclaim any direct or indirect liability as to information contained therein for any industrial, commercial or other use whatsoever

The LNG Importer's Group Study...



- A study by the Technical Study Group of GIIGNL

GDF Suez (secretariat)
BG Group
Chinese Petroleum
DEPA
Dragon LNG
Dunkerque LNG
ELENGY
ENAGAS
E.ON Ruhrgas
FLUXYS LNG

GAIL
Gasunie
GDF Suez Energy NA
GNL Italia
Kansai Electric Power
Kogas
Grain LNG
Osaka Gas
Petronet LNG
REN Atlantico

Sempra LNG
Shell Global Solutions
Southern LNG
Statoil
STREAM LNG
Tokyo Electric Power
Tokyo Gas
Total
Vopak LNG

- GIIGNL Includes the owners and/or operators of nearly all of the world's LNG import terminals
- GL Noble Denton, ActOn LNG and Dunkerque LNG were responsible for analysis and reporting

...The LNG Importer's Group Study



- LNG incident data has been collected from all sources:
 - previous studies by GIIGNL
 - recent incidents at Study Group Member's Terminals
 - public domain information
 - A questionnaire to all GIIGNL Members
- Data collection is anonymous and done regionally:
Americas, Europe, Far East
- Routine operational incidents are excluded
- Data reported here covers the total of LNG commercial operations over 3 time periods from 1965- 2007 and the survey continues

Categories of Incidents Surveyed

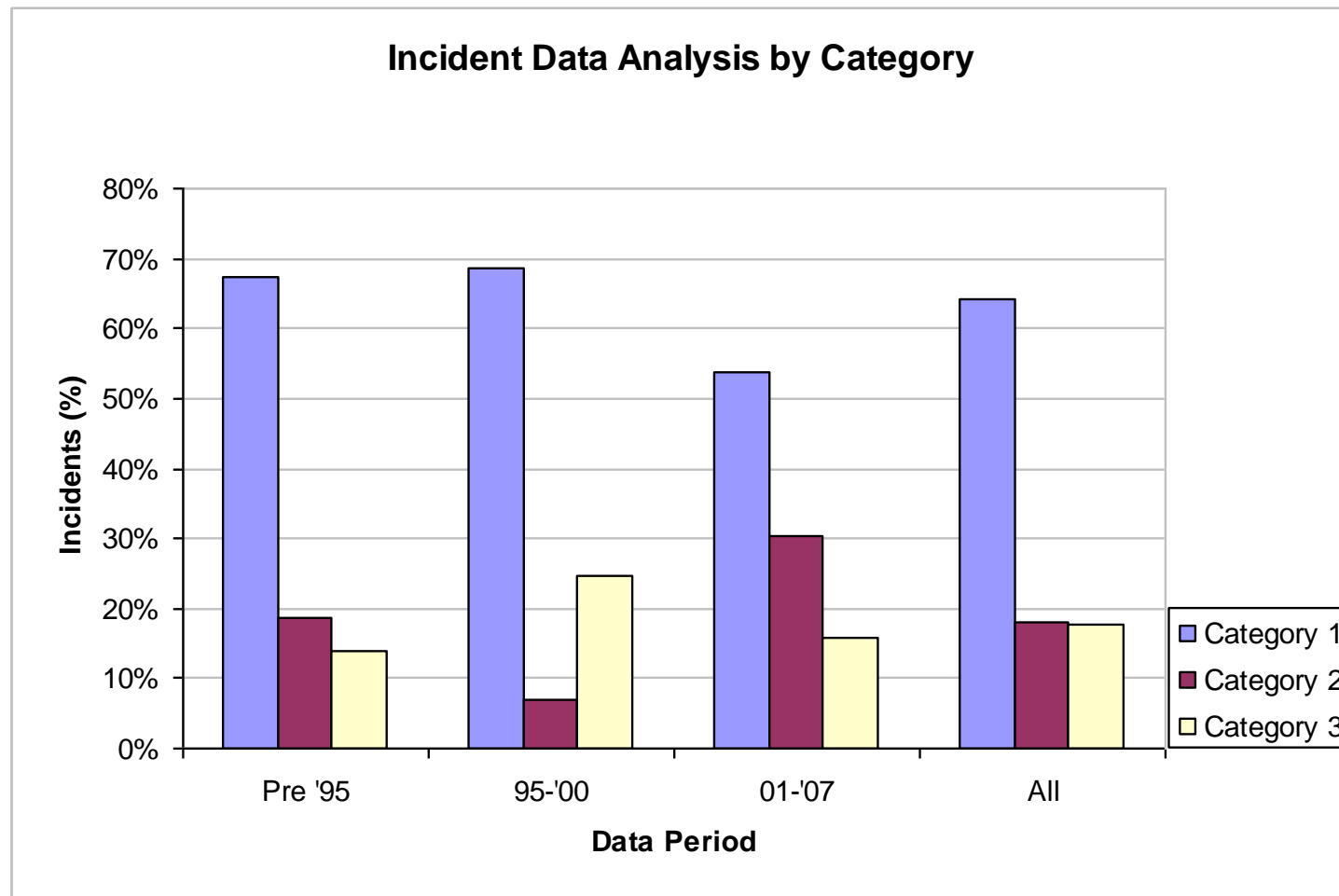


- **Category 1** - Releases of hazardous material: releases of LNG, LPG, NGL, hydrocarbon gases, etc. leading to, or with the potential to lead to, injury to personnel or damage to equipment or buildings on or off site
- **Category 2** – Near misses: incidents involving a hazardous material system where there was no actual release of hazardous material but which had the potential to lead to a Category 1 incident
- **Category 3** – Other incidents of concern: incidents not involving a hazardous material system but which had the potential to lead to a Category 1 incident

The GIIGNL Database contains 328 Incidents in total



Incidents by Category



Releases of hazardous material, near misses and other incidents of concern

Historical Incident Frequencies



Period	Incidents	Operating site-years	Frequency (incidents/site-year)
1965 - 1974	15	44	0.34
1975 - 1984	52	179	0.29
1985 - 1994	94	327	0.29
1995 - 2000	85	191	0.45
2001 - 2007	82	579	0.14
Total 1965-2007	328	1320	0.24

There have been on average only 0.24 incidents of all categories per site-year

Where Incidents Happen



Storage: LNG tanks, in-tank pumps & boil-off gas system

Unloading: LNG ship at berth, jetty & unloading equipment

Send-out: pumps, vaporisers, etc. including any LPG plant

External: equipment outside the control of the LNG terminal

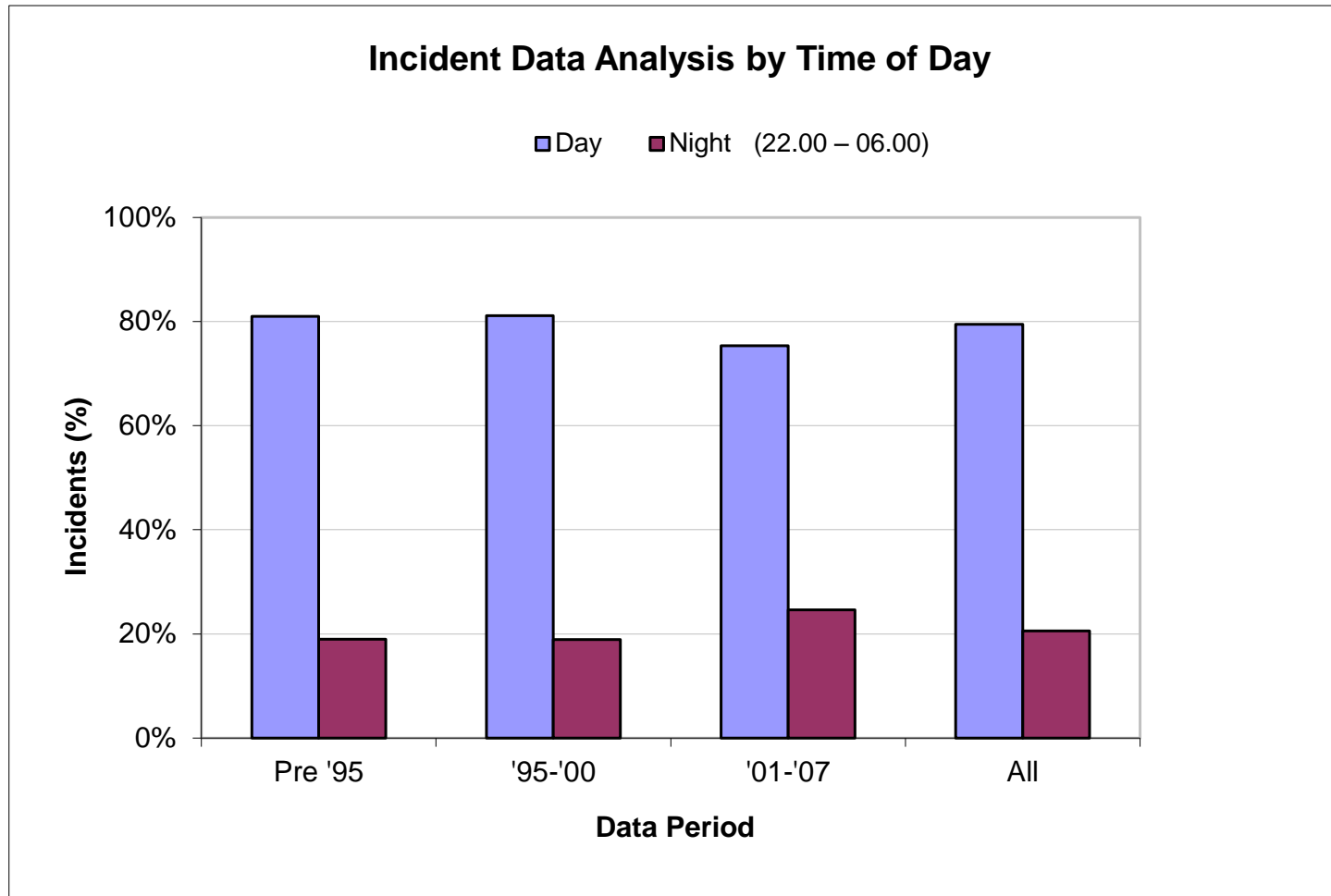
Others: utility & other equipment not included above

Unit Frequencies by Equipment Function

Time period	Storage (per million hours)	Unloading (per million unloading hours)	Sendout (per 10 ⁹ m ³ of LNG)	External (per million hours)	Others (per million hours)
Pre '95	1.34	176.95	54.15	1.71	2.14
95-'00	1.64	166.67	60.96	3.31	10.47
01-'07	1.66	71.28	20.35	0.79	2.56
All	1.49	132.91	41.47	1.56	3.63

Incidents during LNG unloading functions are the most frequent

Incidents During the Day and Night



Fewer incidents occur during the night than during daytime hours



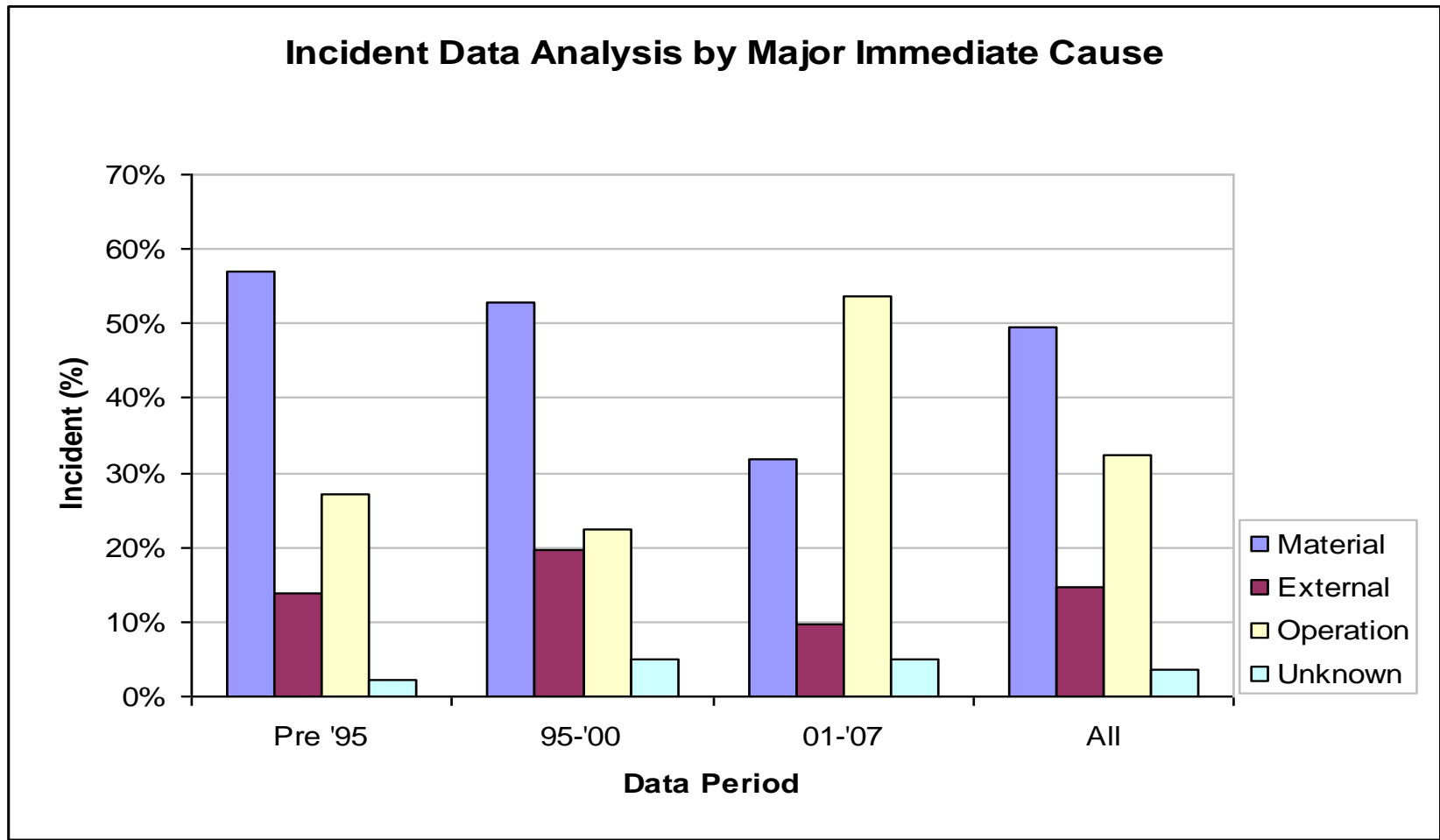
Causes of Incidents

- **Immediate Cause (precipitating event)**
 - **Operation** (actions, including maintenance)
 - **Material** (equipment, materials or installation)
 - **External** (anything out of influence of terminal)
 - **Unknown** (Immediate Cause never found)

- **Primary Cause (underlying cause)**
 - **Design/Construction** (design & installation)
 - **Operation/Maintenance** (equipment failure, operator error, poor procedures, poor maintenance)
 - **External** (anything out of influence of terminal)
 - **Unknown** (Primary Cause never found)

Incidents are often due to a Primary Cause different from the Immediate Cause

Immediate Causes of Incidents

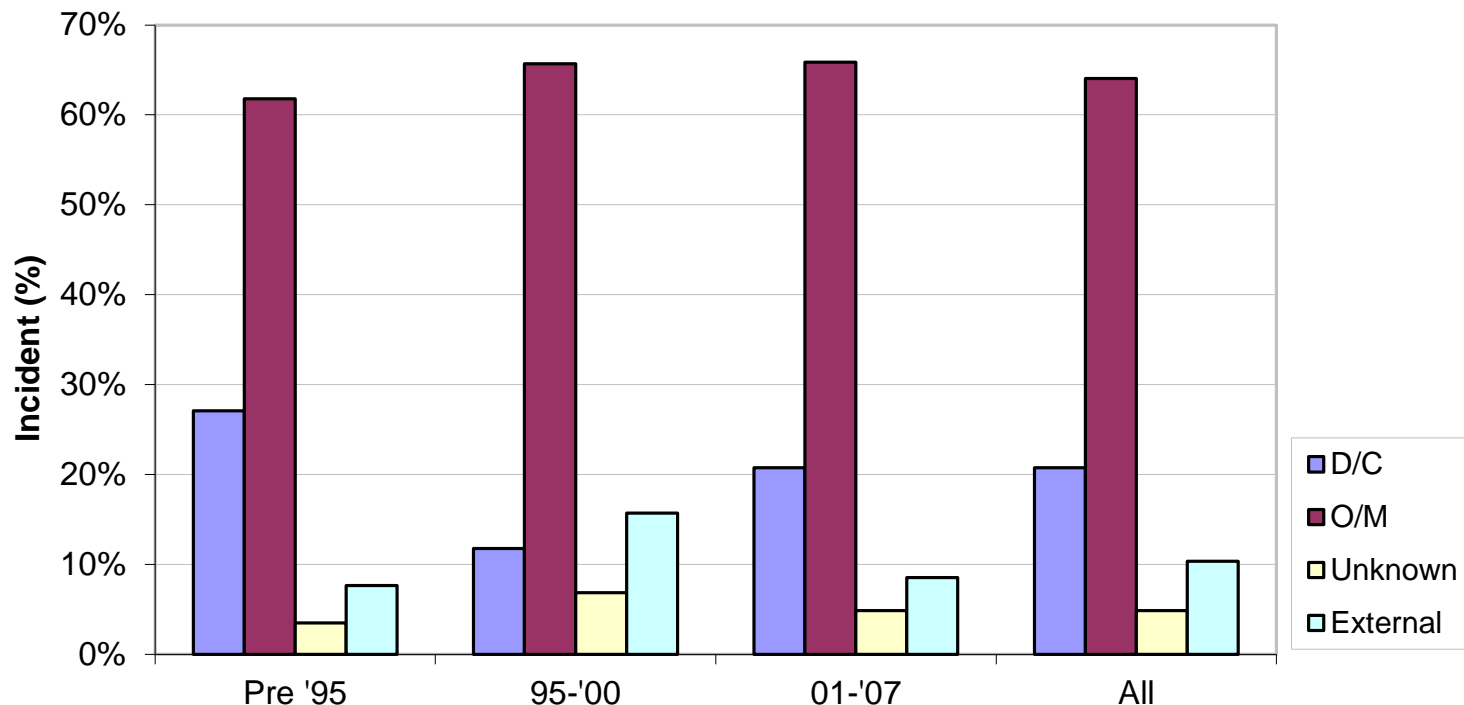


“Operation” and “Material” are the most-likely Immediate Causes of incidents

Primary Causes of Incidents



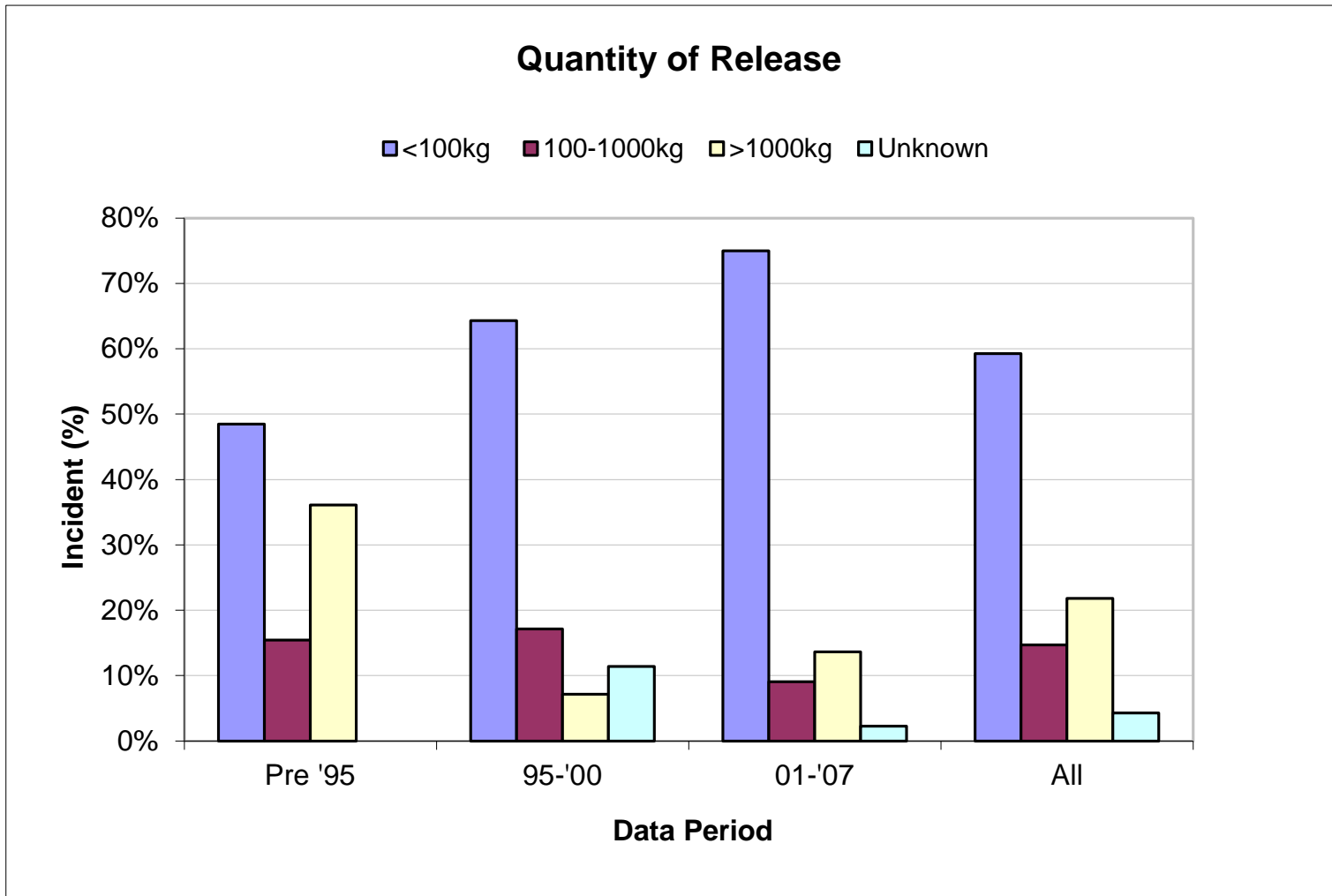
Incident Data Analysis by Main Primary Cause



O&M – Operation & Maintenance D&C – Design & Construction

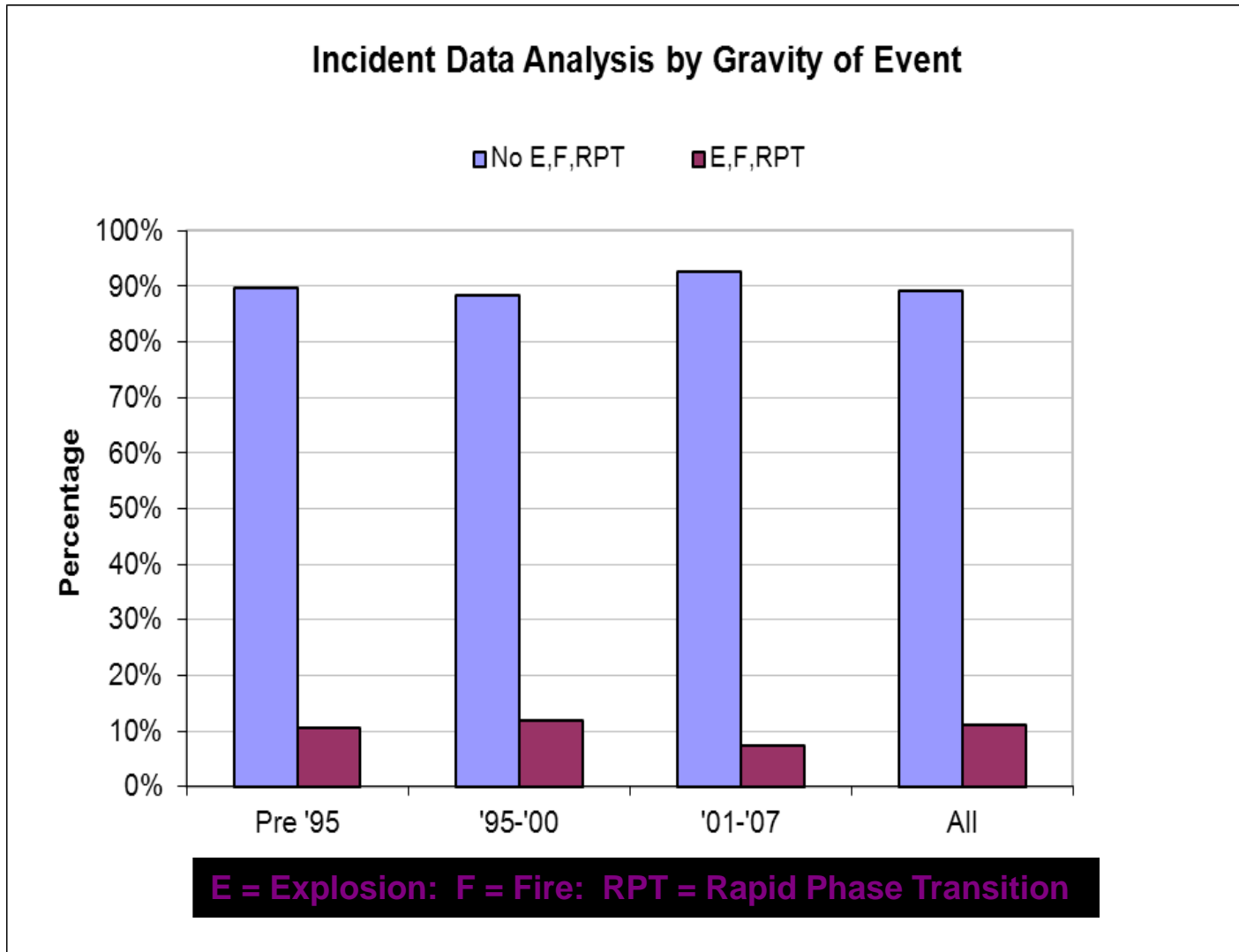
Operation & Maintenance is by far the most-likely Primary Cause of incidents

Incident Analysis by Release Quantity



Some 60 % of all releases are less than 100 kg

Incidents by Gravity of Event



Some 11 % of all incidents resulted in explosion, fire or rapid phase transition

Earthquakes and Tsunamis



- Earthquakes and tsunamis are considered in the design of LNG Terminals (e.g. NFPA 59A & EN1473)
- In only 3/10 instances of large earthquakes (magnitude > 7) near LNG terminals was there any damage and this was minor with no loss of LNG
- In only 1/3 instances of large tsunamis near LNG terminals was there any damage (Minato, Japan, 2011) where some unpiled structures were washed away. The LNG unloading arms and the inground LNG storage tank were unaffected and there were no injuries to personnel

New Data Collection Methods



- Until 2012 all GIIGNL's incident data collection has been by individual questionnaires managed by Regional Co-ordinators and supplied to the Study Group in anonymous electronic form for analysis
- A web-based data collection system allowing operators to enter incident data directly is being implemented in 2013 to improve efficiency. Regional Moderators will still review the entries and seek any clarifications before releasing them to the anonymous database available to GIIGNL Members

Conclusions...



- Since the commercial LNG import industry began in late 1964, there have been no known instances of significant damage outside the LNG facility at which an incident occurred nor of catastrophic LNG storage tank failure. This study has confirmed these facts
- A total of 328 incidents of releases of hazardous material, near misses and other incidents of concern have been reported and analysed in this comprehensive study of GIIGNL Member's facilities from 1965 to 2007
- Safety has improved overall - data from 2000 onwards show:
 - the frequency of reported incidents to be very low, 0.14 per site year, down from 0.24 previously
 - 54 % of reported incidents involving the release of hazardous material, down from 69 % previously
 - 75 % of releases to be less than 100 kg, up from 48 % and 64 % in the two previous periods
 - Only 7 % of incidents resulting in an explosion, fire or rapid phase transition, down from 11 % previously

...Conclusions...



- Operations and Maintenance are now reported as the main Primary and Immediate causes of incidents
- The main sources of hydrocarbon release are from LNG unloading, storage and sendout equipment with storage contributing most to the tally of larger releases
- Incidents during LNG unloading are the most frequent . However, their frequency has reduced recently and they do not contribute excessively to the total number of incidents because LNG unloading is a relatively infrequent operation at LNG import facilities
- There is an increase in the number of truck-related incidents. This may be due to an increase in trucking activities which may often be outside the control of the terminal



...Conclusions

- Fewer incidents occur during the night than during daytime hours
- Earthquakes have had little impact on LNG facilities and in only one case has a tsunami caused damage but with no release of LNG and no injuries to personnel
- The LNG Importer's Group (GIIGNL) believes that maintaining a comprehensive record of incidents will be useful for the future design and operation of safe LNG facilities. GIIGNL is introducing more-efficient ways of collecting incident data and is committed to maintaining its database up-to-date for the general good of the LNG Industry

GIIGNL is committed to improving LNG Industry Safety