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Ship fires in practice

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SYNOPSIS

The purpose of this paper is to discuss, from a practicing Surveyor's point of view, the subject of fires which occur in merchant ships during their normal working life and bring to the attention of interested parties some of the records collated over the 30 year period 1959 – 1988.

Fires in connection with hostile actions do not form part of this paper. Undoubtedly such incidents concern materials, fire detection and firefighting, but due to the origin of that type of fire it is considered to be outside the scope and intent of the present paper.

A number of papers associated with the subject of fires in ships have been presented to this Institute and other Learned Societies in the past. From such records and various libraries it will be seen that the subject has occupied the minds of many highly qualified, experienced and interested persons, throughout the history of shipping. A wealth of statistical data has been produced and this paper contains similar details from the latest reports available. It is hoped that a perusal of this data will prove interesting and of benefit.

A Surveyor appointed to investigate the cause, nature and extent of a ship fire, and the consequential damage, meets with a varying degree of success and some aspects of this are discussed.

Some case histories are described and the paper concludes with some comments regarding future prospects of achieving a significant reduction in the occurrence of fires in ships.

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He obtained a First Class Steam Certificate with Motor Endorsement, has since 1954 occupied various positions in shipbuilding, shiprepairing, shipowning and management organisations, and was a Consulting Engineer and Ship Surveyor prior to joining his present employer in 1973.

He has since then served with the Salvage Association as a Senior Staff Surveyor in the USA, in their Glasgow office, and from July 1982 has been Assistant Technical Adviser in their London Head Office.

INTRODUCTION

Everyone can recognise fire by their sense of sight, sound and feelings, ranging from gentle warmth to excruciating pain. Like many of the familiar things we live with we would not normally need to define fire, but is is perhaps appropriate to start this review at the very beginning.

Basically fire may be defined as heat and light resulting from the rapid combination of oxygen with other materials.

The development and use of fire probably occurred in four stages as follows:

1. Natural sources of fire were observed such as volcanoes, trees and perhaps natural gas set alight by lightning; or trees, grass, and foliage set alight by the sun.
2. Fire was acquired from natural sources and used for protection from wild beasts, for light and for heating.
3. Primitive people learned to make fire from first principles.
4. As knowledge of fire increased it was brought under control for use in cooking, pottery, smelting, and so on, to the stage we have reached today.

Our ancestors learned to make fire by rubbing two pieces of wood together in a particular way or alternatively by striking a flint against a piece of iron pyrites.

Starting a fire by these primitive methods can be quite arduous and is not always successful at the first attempt. Unfortunately the fires which form the subject of this paper do not stem from any great personal effort to achieve ignition. On the contrary every possible effort and precaution is required to prevent fires from occurring in ships.

Fires of varying degree involving ships of all types occur in significant numbers and there is no encouragement to believe that a dramatic reduction can be envisaged.

The design of each vessel constructed and delivered to her owner over the last 30 years, the particular period of this review, together with the materials of her construction and equipment on board, complied with the contemporary rules and regulations of the authorities concerned, including those of the Classification Society concerned. It is how well the vessel is subsequently maintained and manned that is important. There should be no doubt in anyone's mind that when the original standards and concepts are not strictly adhered to fires not only occur but they often reach serious proportions.

Of course it would be unrealistic to suggest that accidents do not occur, however where the vessel is well maintained and the crew adequately trained such fires as do occur are dealt with expeditiously, and frequently limit the outcome to a minimum of consequential damage and repair cost.

Inevitably during some surveys the investigator may find that there is something suspicious about the cause of the fire. The nature and extent of damage can indicate that the fire may have been deliberately started and in such circumstances careful consideration of all available evidence will be required.

The rules and regulations concerning the safety of ships, procedures for handling the enormous variety of cargoes, and so on, occupy a substantial amount of shelf space in the owner's office, on board the ship, and in Surveyors' offices around the world. It is not clear, however, how many of the great variety of personnel involved will have read and understood the contents of those parts of this literature which directly concerns them and a particular voyage.

What is clear is that there are vessels which suffer from a lack of regular maintenance and there are occasions when a willing and capable crew can become demoralised under the circumstances in which they find themselves.

STATISTICS

Fires and explosions may be considered as two entirely separate subjects, however in the context of merchant ships they are sometimes difficult, if not impossible, to separate. Past presentations and indeed all records reviewed by the author list fires and explosions under a single heading. This practice is adopted in the present paper for the same basic reason, but it also serves to provide continuity for the interested reader. This is illustrated for the 30 year period 1959 – 1988 in the attached Figs 1, 2 and 3.

A 30 year period was selected as it seems to provide a reasonable set of results to consider.

The statistics referred to in this paper are for ships of 500 gross registered tonnes and upwards, and are extracted from the returns published in earlier years by the Liverpool Underwriters Association, and currently produced by the Institute of London Underwriters.

Figure 4 lists the total world tonnage recorded for the years 1959 – 1988 inclusive together with the total gross tonnage lost in each of those years by fire/explosion. This does appear to indicate a decreasing trend in the losses experienced. A similar trend was envisaged from the 1968 – 1970 records but that encouraging outlook was not fulfilled in the following years. From Fig 4 it will be seen that the highest losses occurred in 1980 and were 801 446t. In general there are ups and downs and there is no cause for complacency indicated by these results.

It is well to remember that these results are all from merchant ships engaged in normal peacetime commerce and that during these years the capital cost of ships was steadily increasing.

The bar charts, Figs 1, 2, 3 and 5, show the ratio between the percentage of the world total tonnage lost annually to all causes and the percentage of the same world total tonnage lost annually as a result of fire/explosion. These results do not indicate a steady decline in the fire loss percentage, as listed in the final column, but show a continuing similarity in that ratio. It is particularly noticeable that the ratio in 1966 was 30% and that it was the same in 1988, which indicates that no real improvement has been achieved over the period reviewed.

Figures 5, 6, 7, 8 and 9 show an interesting breakdown of the location of the outbreak of fire from which it will be seen that more outbreaks of fire occur in machinery spaces than anywhere else. Perhaps this should not be considered surprising in view of the great variety of combustible materials and equipment installed in, sometimes squeezed into, such spaces. On the other hand these spaces are under continual and expert surveillance and are normally well protected by safety devices, alarm systems and firefighting equipment. The current trend does appear to be that these outbreaks are reducing in number, but the author would suggest that even if this trend were to continue there are still far too many incidents occurring to allow for any real optimism at this stage, particularly when the highs and lows of the past 30 years are examined.

During the latter part of the period under review a significant number of ships have been laid up although this number is

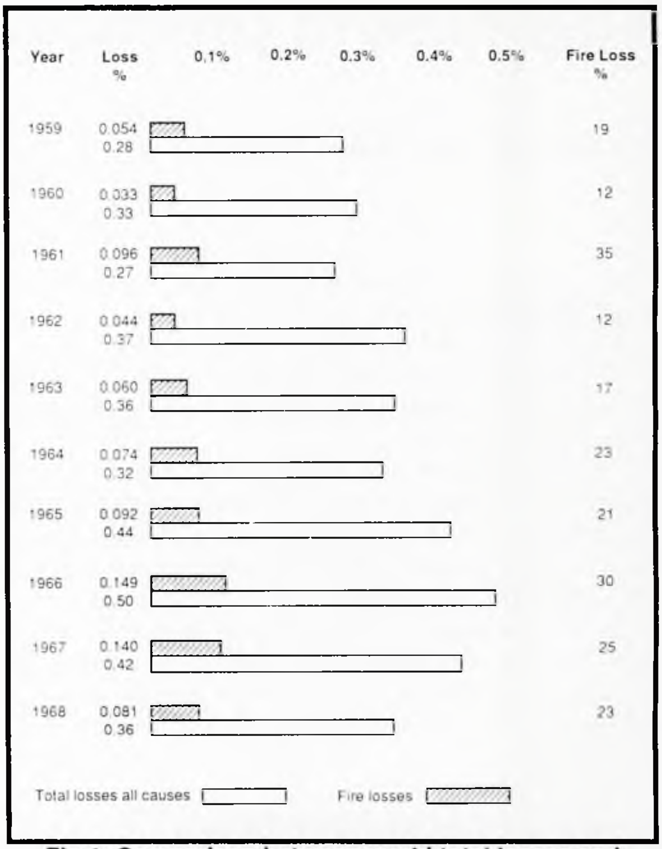

Fig 1: Comparison between world total losses and losses by fire and explosion

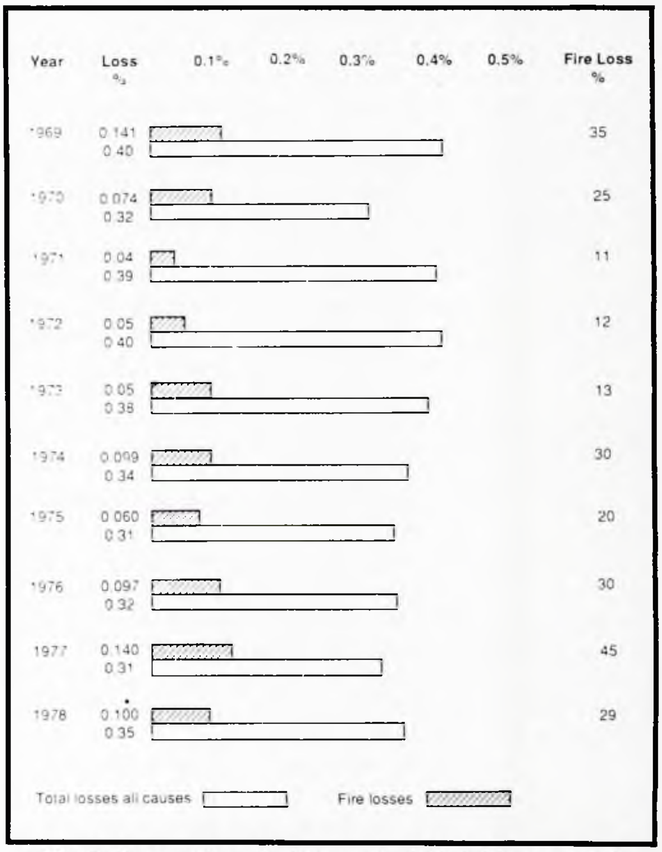

Fig 2: Comparison between world total losses and losses by fire and explosion

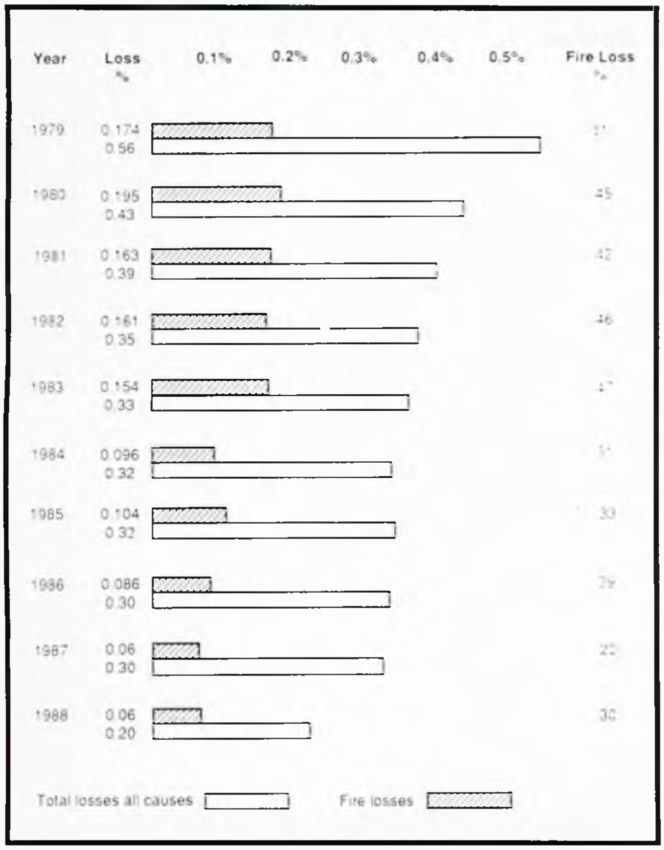

Fig 3: Comparison between world total losses and losses by fire and explosion

Year	World total gross tonnage	Total gross tonnage losses by fire/explosion
1959	121 463 414	65 503
1960	126 246 158	50 192
1961	132 143 280	127 300
1962	136 030 729	60 319
1963	141 744 587	86 202
1964	148 635 526	56 196
1965	155 873 302	144 744
1966	166 465 849	247 147
1967	177 249 686	185 018
1968	188 730 467	152 035
1969	205 781 443	289 069
1970	221 322 771	164 538
1971	240 750 128	254 106
1972	261 539 886	302 543
1973	282 789 525	404 862
1974	303 896 126	302 677
1975	334 424 470	202 673
1976	364 066 852	356 160
1977	385 540 268	541 858
1978	397 738 061	398 939
1979	404 312 794	704 632
1980	410 792 576	801 446
1981	411 635 184	673 717
1982	415 336 602	672 310
1983	413 050 362	637 340
1984	409 176 177	396 855
1985	406 697 595	423 695
1986	395 463 677	339 470
1987	394 018 761	246 876
1988	393 798 970	233 897

Fig 4: Total world tonnage for the years 1959–1988

reducing. Additionally certain order books are filling up to cope with a gradually increasing demand for sea transportation.

The list of cargoes shows that the types of cargo carried over the 30 year period have not altered to any large extent. Of course the growth in the carriage of cargo in containers, and the number of container carrying ships, has been enormous and is still increasing. Some further comments on this subject will be made later in the paper.

The case histories available to the author are contained in files of surveys carried out on behalf of Underwriters. Certain data is extracted from each file and placed in a database which can then be retrieved on a computer printout. Due to the inevitable time lapse between the date of the survey and feeding the extracted details into the database, the latest 12 month printout available at the time of writing of this paper is for the year 1986. In 1986 there were 199 vessels surveyed in respect of fire/explosion. The cost, or estimated cost, of repairs for these ranged between £1340 and £9.56M. In 1985 the highest repair cost for damage caused by a fire ignited by a welder was £50M. That was for one repair on one vessel.

SOME CASE HISTORIES

A large number of case histories available to the author have been reviewed. These cover a broad range involving, at the lower end of the scale, minor repair costs and, at the higher end, involving the total loss, often the constructive total loss, of expensive ships. It is obviously impossible to tabulate such a diversity of incidents, or to describe more than a selected few of them within the confines of this paper.

It will also be appreciated that names of vessels are necessarily withheld, however the cases selected, which are representative, will hopefully be found interesting and informative.

Tanker fires in general

Doubtless the headline cases which occurred in the 1960s are still well remembered, as well as the background to the development from that era of the inert gas system.

Great care must be taken with an inert gas system to ensure that is is operating satisfactorily, and that a false sense of security does not prevail.

For instance one major tanker operator based in the USA has reported finding that after loading certain oil product cargoes into inerted cargo tanks a high level of oxygen was observed, exceeding 14% in some cases. Following a scientific study it was calculated that loading a fully oxygen saturated cargo to 95% capacity of a fully inerted tank having a zero oxygen content would result in a level of 17% of oxygen in that tank. The company concerned has standing instructions that the oxygen content must be limited to 5%.

Fires and explosions continue to occur in tankers. Who would have thought, following the headline cases referred to above, that one would still read about fires and loss of life involving 'hotwork' inside tank spaces of tankers in 1989, and that the subject of gasfreeing and cleaning to 'hotwork' standard would remain a matter for discussion and conjecture in connection with the reasonable cost of repairs.

Most importantly the issuing of a gasfree certificate permitting 'hotwork' to be carried out can provide those engaged in a repair with an entirely erroneous view of their safety for several possible reasons, such as:

1. The analyst's inexperience of the type of work involved.

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
World gross tonnage (in millions)	114.7	121.5	126.2	132.1	136.0	141.7	148.6	155.8	166.4	177.2	188.7	205.7	221.3
Total losses due to fire or explosion) No	6	13	8	20	13	23	15	22	38	32	33	33	30
) Gr tons	31 352	65 503	50 192	127 300	60 319	86 202	56 196	144 744	247 147	185 018	152 035	289 069	164 538
Outbreaks discovered at sea	109	106	109	168	128	109	114	121	131	141	174	168	167
Outbreaks discovered in port:													
i. under repair	56	63	48	51	50	43	46	50	45	34	41	38	36
ii. not under repair	234	259	262	251	276	287	277	296	324	279	262	260	244
TOTALS	**399**	**428**	**419**	**470**	**454**	**439**	**437**	**467**	**500**	**454**	**477**	**466**	**447**
Outbreaks known to be due to)Welding	16	25	14	19	16	13	14	13	11	12	9	15	8
)Collisions	13	6	7	2	7	8	7	11	12	7	6	9	3
)Oil residue	10	6	8	8	8	8	8	7	10	7	7	5	4
Location of outbreaks include:													
Accomodation	33	42	32	52	46	53	45	54	58	50	64	69	61
Cargo spaces	156	159	146	178	188	193	177	175	180	172	2	162	147
Electrical installations	20	21	19	11	10	20	11	14	11	9	14	13	6
Funnels and uptakes	3	6	9	7	10	5	4	5	6	4	4	1	–
Galleys	10	4	10	15	4	8	8	14	17	14	7	8	8
Insulation	13	10	8	2	–	6	9	3	3	1	1	–	–
Machinery spaces	33	57	55	79	67	61	75	68	97	96	93	108	126
Oil burning stokeholds	28	24	15	27	29	20	26	22	26	23	30	26	21
Oil tanks	8	23	14	12	8	11	7	6	9	13	7	11	14
Stores	17	13	20	13	8	8	11	12	13	12	5	8	2
Cargoes affected include:													
Chemicals	3	8	5	2	5	10	8	9	9	8	9	7	4
Coal and coke	11	13	7	5	5	11	3	4	11	4	10	8	4
Copra	3	1	2	3	6	10	8	10	19	8	9	5	7
Cotton	14	20	17	20	19	28	24	21	24	22	19	23	19
Dunnage	5	2	3	–	1	1	–	1	1	–	–	–	–
Esparto	–	1	–	1	–	2	–	–	1	–	–	–	–
Fish Meal	19	9	20	22	29	15	22	16	16	5	6	8	11
Gas Cylinders	2	1	1	–	–	–	–	–	–	–	–	–	–
General	14	18	15	10	20	18	15	26	17	25	22	30	33
Grain and meal	7	10	7	7	1	9	7	6	8	5	5	7	3
Jute	6	7	6	1	6	14	9	12	6	12	8	10	5
Kernels	5	9	5	2	2	6	2	6	3	3	3	2	–
Matches	3	2	2	1	2	–	–	–	–	1	1	1	–
Metal borings and scrap	–	1	–	4	1	3	4	–	3	3	6	3	5
Oils	1	1	1	–	3	4	1	4	5	2	10	6	6
Paper	1	2	4	2	4	–	2	2	4	6	3	3	1
Pyrites and concentrates	4	2	1	2	1	1	–	1	–	–	–	–	–
Seed expellers and oilcakes	6	13	17	18	21	13	18	10	20	15	14	18	10
Sisal	–	–	4	3	4	1	7	5	–	2	2	3	3
Sulphur	13	8	4	4	7	5	9	5	5	8	11	4	4
Tarpaulins	5	1	2	2	–	–	–	–	–	–	–	–	–
Timber	–	–	1	2	7	4	1	4	3	1	10	6	2
Wool	1	3	–	2	1	4	1	1	2	3	2	–	1

Fig 5: Reports of fires and explosions 1958 – 1970

	1971	1972	1973	1974	1975
World gross tonnage (in millions)	240.7	261.5	282.7	303.9	334.4
Total losses due to) No	42	53	50	54	48
fire or explosion) Gr tons	254.106	302.543	404.862	302.677	202.673
Outbreaks discovered at sea	154	173	202	166	132
Outbreaks discovered in port:					
i. uder repair	25	41	13	16	18
ii. not under repair	203	213	251	220	216
TOTALS	**382**	**427**	**466**	**402**	**366**
Outbreaks known to be due to)Welding	9	10	4	5	4
Outbreaks known to be due to)Collisions	5	10	12	7	6
Outbreaks known to be due to)Oil residue	3	3	4	3	3
Location of outbreaks include:					
Accomodation	54	68	40	59	44
Cargo spaces	126	126	124	84	94
Electrical installations	6	2	6	16	8
Funnels and uptakes	1	1	–	1	–
Galleys	1	1	2	5	2
Insulation	1	–	–	–	–
Machinery spaces	105	112	117	97	103
Oil burning stokeholds	18	19	18	18	17
Oil tanks	8	12	6	2	4
Stores	1	1	5	5	1
Cargoes affected include:					
Chemicals	6	11	8	13	11
Coal and coke	4	6	2	4	6
Copra	3	1	8	2	2
Cotton	23	20	26	24	19
Fish Meal	2	3	1	1	2
General	17	20	22	18	19
Grain and meal	3	4	15	10	7
Jute	7	7	6	7	4
Kernels	3	2	1	1	2
Matches	1	1	–	–	1
Metal borings and scrap	–	2	5	7	2
Oils	4	8	2	5	7
Paper	2	5	1	1	–
Pyrites and concentrates	–	–	1	–	–
Seed expellers and oilcakes	9	16	12	1	–
Sisal	1	1	3	1	1
Sulphur	1	1	3	3	1
Timber	2	7	4	5	8
Wool	1	1	1	–	2

Fig 6: Reports of fires and explosions 1971 – 1975 (total and partial losses)

2. The gasfree certificate not being updated as repairs proceed.
3. Insufficient attention being paid to the possible formation of localised areas of volatile gas as repairs progress, particularly in certain climates.

The British Regulations covering this state that the gasfree certificate must be issued by a competent analyst. But as far as the author is aware the qualifications of a competent analyst are not defined.

The author has recently made enquiries in the UK about the training of persons for the purpose of allowing them to issue gasfree certificates. One university operates a four day course covering the theoretical aspect and recommends that this be followed by tuition in the practical application within industry. It seems that one should have a good background in chemistry, and then obtain tuition and experience by associating with established experts, who are already well known and heavily engaged in this discipline. However it does not seem very likely that there are many opportunities for this practical experience in the UK shipbuilding/shiprepairing industry today.

Chemical carriers

Some very sophisticated chemicals are carried on modern ships. The reference manuals are extensive. Fire might not be thought to be the immediate problem, however as an example one case involving a motor cargo vessel provides an indication of what can be involved.

This vessel was discharging a pallet of drums containing methylethyl retone peroxide and in the process one drum fell from the pallet. Combustion occurred which spread to the other drums in the vicinity on the ship's deck and in the hold. The ship side plating was extensively distorted and cracked, and the accommodation and bridge structure were completely gutted.

	1976	*1977*	*1978*	*1979*	*1980*
World gross tonnage (in millions)	364.0	385.5	397.7	404.3	41
Total losses due to fire or explosion) No	57	65	71	63	56
) Gr tons	356.160	541.858	398.939	704.632	801.446
Outbreaks discovered at sea	132	148	140	139	130
Outbreaks discovered in port:					
i. under repair	12	14	16	24	22
ii. not under repair	205	198	191	180	162
TOTALS	**349**	**360**	**347**	**343**	**314**
Outbreaks known to be due to)Welding	4	4	8	4	5
)Collisions	1	7	–	15	6
)Oil residue	2	2	3	1	1
Location of outbreaks include:					
Accomodation	27	23	31	25	24
Cargo spaces	85	82	72	65	62
Electrical installations	2	2	7	11	13
Funnels and uptakes	–	3	–	–	–
Galleys	3	5	6	3	4
Machinery spaces	99	125	109	118	113
Oil burning stokeholds	8	13	13	11	5
Oil tanks	1	–	1	5	2
Stores	4	2	–	4	5
Cargoes affected include:					
Chemicals	11	9	7	10	4
Coal and coke	3	2	2	4	10
Copra	2	3	3	2	1
Cotton	10	16	8	12	8
Fishmeal	1	3	3	–	1
General	21	4	24	13	13
Grain and meal	7	4	7	2	9
Jute	8	4	3	3	3
Kernels	–	–	1	1	2
Metal and scrap	3	–	5	6	3
Oils	12	10	7	9	16
Paper	2	2	–	2	3
Seed expellers and oilcakes	5	3	–	–	2
Sisal	1	2	–	3	–
Sulphur	–	–	1	3	–
Timber	5	6	8	5	6
Wool	–	3	–	–	–

Fig 7: Reports of fires and explosions 1976 – 1980 (total and partial losses)

LNG/LPG ships

This may well be considered as one type of ship more prone to serious accidental damage than any other. However, past experience indicates that this is not so. Obviously all parties engaged in this trade not only recognise the need for concentrated effort but are fully aware of the drastic consequences which could arise if the safety procedures are not strictly adhered to by everyone associated with the handling of this type of cargo, both on ship and one shore.

In the main, surveys on this type of vessel have been normal surveys in respect of alleged machinery and equipment damage. One series of vessel experienced rudder associated problems and others had damage involving gas leakage, causing associated hull structural problems.

However, there have been a few spectacular incidents. One of these concerned a 4500 gross registered tonnes ship which, whilst discharging LPG, sustained an explosion and fire in the driving motor compartment of the gas compressor house. The explosion blew out the aft bulkhead of the compressor which sheared off the discharge line from the cargo pump and LPG then sprayed burning liquid gas over the aft accommodation. The entire aft end of the vessel was set alight and took 72h to bring under control. In view of the danger to the shore installation the vessel was towed away and beached and consequently sustained bottom damage and flooding of the engine room.

Ships under construction

On a large vessel under construction during the month of January the nightshift labourers were instructed to remove accumulated water from a compartment. An eductor unit with hoses was rigged up but after commencing operation the eductor froze up. The operator involved used a propane torch to defrost the eductor and dewatering continued. Shortly after this water ceased to flow from the discharge outlet and the operator laid the torch, still burning, on the deck whilst he entered the compartment to investigate. On his return to the deck he found various hoses in the area were on fire. He switched off the propane torch and went ashore to report the fire. The local fire brigade arrived and found air, propane and

	1980	1981	1982	1983	1984
World gross tonnage (in millions)	410.8	411.6	415.3	413.0	409.2
Total losses due to fire or explosion) No	56	69	72	66	56
Total losses due to fire or explosion) Gr tons	801.446	673.717	672.310	637.340	396.855
Outbreaks discovered at sea	130	144	162	134	127
Outbreaks discovered in port:					
i. under repair	22	22	15	20	23
ii. not under repair	162	188	152	132	110
TOTALS	**314**	**354**	**329**	**286**	**260**
Outbreaks known to be due to)Welding	5	12	3	8	9
Outbreaks known to be due to)Collisions	6	–	1	–	–
Outbreaks known to be due to)Oil residue	1	–	4	3	1
Location of outbreaks include:					
Accomodation	24	30	47	25	25
Cargo spaces	62	99	58	46	52
Electrical installations	13	9	7	5	11
Funnels and uptakes	–	1	–	–	2
Galleys	4	3	1	–	3
Machinery spaces	113	108	103	112	99
Oil burning stokeholds	5	9	8	3	1
Oil tanks	2	3	1	–	1
Stores	5	–	–	–	1
Cargoes affected include:					
Chemicals	4	6	5	5	8
Coal and coke	10	24	4	3	5
Copra	1	1	4	2	–
Cotton	8	9	5	10	3
Fishmeal	1	2	1	1	1
General	13	20	9	19	16
Grain and meal	9	15	11	12	6
Jute	3	1	–	–	–
Kernels	2	–	–	–	–
Metal and scrap	3	5	9	6	5
Oils	16	9	16	19	7
Paper	3	4	4	2	4
Seed expellers and oilcakes	2	2	3	2	1
Sisal	–	2	–	–	–
Sulphur	–	–	1	1	2
Timber	6	3	–	1	2
Wool	–	3	–	–	–

Fig 8: Reports of fires and explosions 1980 – 1984 (total and partial losses)

oxygen supply hoses burning. The propane and oxygen supplies were shut off at source and the fire extinguished.

In another case a 10 500 dwt fully refrigerated vessel was less than two months from delivery date and afloat at the fitting out berth. A welder was welding the main engine collision chocks to the tank top when welding spatter ignited oily rags and pipe insulation floating on the surface of the diesel oil/water mixture in the vicinity. Three portable fire extinguishers were operated, one correctly and two incorrectly. The fire escalated rapidly causing substantial damage to the ship, machinery and equipment. The repairs took approximately 11 months to complete and the ship's delivery was delayed accordingly.

Ships under repair

A 9000 gross registered tonnes cargo ship sustained grounding damage and was under repair on the railway of a synchrolift dock. Significant bottom shell plating repairs were in hand and at various stages of progress with some plates renewed, some tacked in place and some openings awaiting closure. Concurrently various repairs were in hand on the vessel, notably in the machinery spaces, by both crew and shipyard workers. During the course of repairs smoke was observed issuing from the open engine room hatchway, located on deck just forward of the accommodation block, and the alarm was raised. Investigation revealed that there was oil residue in the engine room bilges, and also probably hydraulic oil due to repairs in hand with the electro-hydraulic ballast valve system adjacent to the seat of the fire.

In this case the disposition of the fire and its severity eliminated the possibility that it was as a result of a burning or welding operation. An electric cable found lying in the area was also eliminated as a source of ignition.

No evidence was found to encourage the belief that the fire had been deliberately started and it was concluded that it was most probably caused by an unknown person carelessly disposing of a lighted cigarette, or match, which ignited the oily rags and oil present. This could have occurred in the vicinity of the fire, or the igniting medium could have fallen from one of the platforms higher up in the engine room.

	1984	1985	1986	1987	1988
World gross tonnage (in millions)	409.2	406.7	395.5	394.1	393.8
Total losses due to fire or explosion) No	56	50	38	28	34
Total losses due to fire or explosion) Gr tons	396.855	423.695	339.470	246.876	233.897
Outbreaks discovered at sea	127	112	94	69	81
Outbreaks discovered in port:					
i. under repair	23	18	26	15	18
ii. not under repair	110	87	52	41	47
TOTALS	**260**	**217**	**172**	**125**	**146**
Outbreaks known to be due to)Welding	9	7	6	4	5
Outbreaks known to be due to)Collisions	–	–	–	1	1
Outbreaks known to be due to)Oil residue	1	6	–	1	2
Outbreaks known to be due to)Electrical	–	10	4	3	4
Location of outbreaks include:					
Accomodation	25	18	18	20	21
Cargo spaces	52	31	40	25	27
Electrical installations	11	11	12	4	5
Funnels and uptakes	1	3	3	1	1
Galleys	3	2	–	1	1
Insulation	–	1	–	–	–
Machinery spaces	99	57	43	47	55
Oil burning stokeholds	1	-	3	2	2
Oil tanks	1	3	4	5	6
Stores	–	1	1	2	2
Cargoes affected include:					
Chemicals	8	5	3	4	3
Coal and coke	5	2	–	1	1
Copra	–	-	–	–	–
Cotton	3	3	2	3	3
Fishmeal	1	3	1	3	2
General	19	5	–	1	1
Grain and meal	6	1	1	2	2
Jute	–	3	1	–	–
Kernels	–	-	1	2	1
Metal and scrap	5	2	1	1	2
Oils	7	3	5	2	2
Paper	4	1	–	–	1
Seed expellers and oilcakes	1	–	–	–	–
Sisal	–	–	1	–	–
Sulphur	2	–	–	3	1
Timber	2	–	1	–	2
Wool	–	–	–	1	1

Fig 9: Reports of fires and explosions 1984 – 1988 (total and partial losses)

Another incident occurred on a 9700 gross registered tonnes vessel which was under repair alongside a ship repair facility awaiting a dry dock vacancy. One of the diesel generators was in operation providing electrical power when a fire occurred in the vicinity, and was propagated upwards causing extensive damage to equipment en route, the engine control room and No 4 cargo hold. The ship's CO_2 system did not extinguish the fire and this was accomplished by the shore fire service using seawater. Investigation revealed that the fire originated in a metal junction box located alongside the diesel engine concerned. This box was a connection point for various sensors and thermocouples. The lid of the box had obviously been left off for a long time as the four securing screws had rusted into position. Some of the wiring had recently been renewed and it was concluded that a spark had occurred in the box, was not confined therein due to the missing lid, but even worse it was found that the cables were made of highly combustible material. Thus once the fire commenced it spread rapidly along these cables and as a consequence serious damage was sustained by the ship.

Ships in service

A 1697 gross registered tonnes refrigerated cargo vessel engaged in the fishing industry was at anchor. No 2 generating set had a leaking exhaust manifold gasket and the engine crew were in the engine room attempting to start No 1 generator in order to take the load on No 1 prior to stopping No 2 generator for repair. It is reported that gas oil leaked from a fuel pipe union connection and sprayed onto the hot exhaust line, burst into flames and the ensuing fire rapidly escalated. The crew escaped with the clothes they were wearing.

A passenger/cargo ro-ro vessel was approximately two hours out from port, loaded with trucks and trailers, when a mist was observed to be forming over the starboard main engine which suddenly ignited into a ball of flame. The engine was stopped and an attempt made by the engine room staff to extinguish the fire, but conditions deteriorated rapidly and they were forced to evacuate the space. The port engine was stopped, all remote control closing valves shut, the engine room sealed off and flooded with CO_2. Boundary cooling was carried out by the ship's fire party, and approximately two hours later a firefighting team was placed on board by helicopter. The apparent cause of this fire was the failure of a copper pipe fitted on the fuel booster line to the starboard main engine. Originally this pipe, which led to the pressure gauges at the forward end of the engine and the engine control room, was made of steel down to a needle valve restriction fitted in the line, and then from this a copper line led to the pressure gauges. At some time this steel pipe had been cropped and a copper insert pipe fitted which was secured by a compression type coupling. The copper insert pipe failed where it entered into the coupling and allowed diesel oil under pressure to spray directly onto the main engine turbocharger and ignite. Damage was mainly contained in the engine room with soot and oily smoke deposits in the auxiliary engine room and vent trunkings.

In a separate incident an engine room fire occurred and immobilised a 9200 gross registered tonnes ship with nearly 500 people on board. Investigation revealed that two studs on the top cover of a luboil filter had broken and this had allowed luboil to spray onto an adjacent exhaust manifold and ignition occurred.

Whilst on the subject of fires in machinery spaces it is relevant to mention scavenge fires. Scavenge fires do continue to occur and on occasions result in extensive and expensive damage. It is not unusual for Underwriters' surveyors to be asked to agree that such fires are wholly attributable to crew negligence. One typical and recent example of this was a case where it was agreed that the shipowner was aware that a cylinder liner was worn beyond the recommended maximum limit at its upper end. It was also stated that there was an intention to renew the liner on some unspecified date in the future. Nevertheless when serious engine damage occurred as a result of gas bypassing the piston rings and piston it was alleged by those putting forward the claim to Underwriters that the damage was a result of crew negligence.

Another area for concern in machinery spaces is in the uptakes of exhaust gas boilers and economisers. Serious fires occur due to a build up of soot and it is not always fair to put the entire blame on the ship staff in such cases. This equipment is not easy to maintain in a soot free condition and the design, including sootblowing and sootblower orientation, sometimes leaves much to be desired.

Naval ships

Ships of the various types and sizes required by a country's naval force are often surveyed whilst under construction and repair, for example in connection with a Shipbuilder's Legal Liability Policy.

One case of interest involved a naval vessel under construction outside the UK which was nearing completion and was afloat alongside the fitting out berth. A fire was observed originally by the smell and the sight of smoke in an accommodation area at about 1000 hours. The fire was reported under control by 1547 hours and extinguished some 6h after this. Approximately 80 workmen were on board the vessel at the time and two main entrances were open with the usual various hoses and cables leading through them. The seat of the fire was in the upper deck midship section. Various cabins and items of sensitive equipment in this area were destroyed and other compartments throughout the vessel were heavily affected by heat and smoke. A compartment containing batteries was flooded and polluted. Chlorine gas was formed and reacted with water to form hydrochloric acid and consequently extensive corrosion occurred. The cause was investigated by various interested parties and the final consensus of opinion was that the fire was most probably associated with the electric welding of a pipe clip to the underside of a deck plate, without those concerned checking what was installed/attached in way of the topside of the deck plate.

Cargo fires

Fires still occur in cargo holds, with coal and cotton being particularly worthy of careful attention by a modern generation not as well versed in this trade as their predecessors.

If coal is carried strictly in accordance with recognised procedures the risk of spontaneous combustion is substantially reduced. One recent case involved a bulk carrier loaded with 35 512t of low volatile lump fuel coal. At 0800 hours one morning it was noted that the surface temperature of the coal in No 7 hold was higher than in the other holds and when the cargo hatch was opened the coal surface was smoking/steaming. When the smoke cleared it was noted that one pocket remained and when this area was investigated by digging down half a metre no temperature difference was found, but it was found that the coal was wet. The hatch was closed some 8h later and after about 15 min an explosion blew off two of the hatchcover panels, after which blue flames were observed emanating from the area previously investigated. Firefighting with foam from the vessel's plant, replenished from shore, took place over two days and was unsuccessful. The hatchcover panels were temporarily repaired and a CO_2 system installed. No 7 hold was flooded with seawater and the fire extinguished after the appropriate calculations had proved this flooding to be acceptable. The vessel proceeded to her discharge port and was discharged, although during discharge fire also broke out in No 6 hold.

Damage consisted of buckling and distortion of the No 7/No 6 hold common bulkhead and four hatchcover panels, together with other sundry damages.

It was reported by the Master that part of the cargo had been brought on board wet from inland in open rail wagons and the loading had been carried out during periods of rain, but that his protests about this had been over-ruled.

The Master had no definitive information about the class of cargo loaded but did have, and was familiar with, the IMO regulations carried on board. He proceeded on the voyage following such regulations as best he could until the rise in temperature was observed and luckily the vessel reached a port where outside assistance could be provided.

Fires in containers

The incidence of fire originating within containers on board ship, at sea or in port, that have been brought to Underwriters' attention is remarkably low considering the total number of containers in service world-wide.

From the records available to him this author has been able to trace only two incidents involving Underwriters in the past 10 years.

The first case concerned 18 in number 20ft containers in which were stowed 590 in number 40 gallon drums. These second-hand drums contained solidified zinc dust originating from a galvanising plant. The drums were covered by non-airtight sheet metal lids, were variously corroded, and each had between 4 and 10 holes drilled in them at some time after filling.

Whilst the ship was proceeding on her loaded voyage an explosion occurred in No 1 hatch which lifted the hatchcovers by about 8ft and consequently substantial damage was sustained.

It appeared that the zinc dust had been placed in the drums while wet and it was concluded that there could have been a reaction between the metallic zinc and moisture resulting in the production of hydrogen, which escaped from the drums into the containers, and also into the cargo hold, the explosion and fire being caused by ignition in air.

According to IMO recommendations the zinc residue should have been loaded and carried in a dry state free of moisture/ water.

The second case concerned a container vessel which went on fire in No 6 hold whilst at sea. Initial attempts were made to extinguish the fire with CO_2, but in the event this was accomplished by partially flooding No 6 hold.

It was agreed that the fire most probably originated in a container carrying matches, but the source of ignition was not established.

Of the 40ft containers involved, nine were destroyed, three were declared constructively totally lost, and 50 required attention ranging from washing, cleaning and deodorising through to substantial structural repair. Others suspected of being damaged were surveyed and found to be in good condition.

The total number of containers in use world-wide at any given moment must be enormous and the above two incidents, albeit very expensive ones, should be considered in the context.

It is tempting to conclude that this lack of fires within containers is due to the fact that containers are filled under carefully supervised conditions, and that in this respect the rules for the carriage of cargo in sealed containers are substantially adhered to.

CAUSES OF FIRES IN SHIPS

Some representative examples of the cause of fires in ships have been given above. However, establishing the cause of a fire can be an extremely difficult assignment for a Marine Surveyor to carry out. In a substantial number of cases, inevitably the most severe and dramatic ones, the evidence which may have assisted in locating the cause is destroyed, not necessarily wilfully, as conscientious attempts made to save human life, the vessel and her cargo, can also result in the unavoidable destruction of evidence.

Establishing the cause can be relatively simple when a fire is extinguished at an early stage.

Where more extensive damage has been caused prior to the fire burning itself out, say an engine room fire which spread to the accommodation block, surveyors sometimes find evidence that indicates an effort having been made to fuel the fire. This can take the form of a wired open test cock on a fuel service tank, or an uncoupled fuel oil pipe between a settling tank and purifier. On occasions valves have been found with their remote control mechanisms wired up so that they could not be closed from deck as designed.

On many occasions surveyors find safety devices/alarms immobilised, the reason given for this usually being that they are faulty and sounding off continually, and they have been immobilised with the intention of repairing them at some future date.

In certain cases a Fire Expert will be appointed, usually a consultant chemist or scientist with a proven track record of fire investigation. He will be instructed to establish the cause of the fire, or if this is not possible to give his opinion on the most probable cause of the fire.

Nevertheless it is still incumbent upon the Marine Surveyor to represent his instructing Principal and produce a report reflecting his own knowledge and experience on the operation of the ship, her crew, and the duties of others who might be involved, albeit on occasion in conjunction with the independent Fire Expert.

More outbreaks of fire occur in machinery spaces than anywhere else, frequently due to a spray of fuel oil, or luboil, impinging on a hot surface and igniting. Another frequent cause of very expensive fires is burning or welding on a bulkhead/deckhead/deck adjacent to a space containing flammable material or gas, or doing the same thing on deck close to a vent pipe of a tank which is gaseous. Many lives have been lost and extensive damage caused by such actions in the past.

Similar incidents are occurring as this paper is being read.

CONCLUSION

There is nothing original to be found in the fires continually occurring in merchant ships in 1989, as compared to the fires of previous years, and there is no single outstanding cause of the fire associated casualties experienced.

Human error, negligence, lack of maintenance of the ship and equipment, failure to follow the lessons of past experience and carefully drawn up procedures are all factors which contribute to the losses sustained.

Extensive research and development has taken place and a wealth of information placed on record. Regulatory authorities have defined the various parameters and issued rules and regulations which are updated as consensus of opinion dictates. Vast improvements have been made within the lifespan of the author as regards ship design, materials of construction, early warning systems, safety and firefighting systems.

These improvements are the result of a great deal of time, effort and cost, by concerned and responsible people, and the seafarer must be eternally grateful for this.

Nevertheless from the substantial number of fire associated casualties investigated on behalf of Underwriters it is quite obvious that the subject remains a matter for concern. Consequently financial losses of many millions of pounds sterling can be expected to remain a factor affecting all those worldwide interests involved with merchant shipping.

It should be appreciated that the financial loss due to a fire, ie the total loss, constructive total loss, or repair cost of a ship is only part of the story. There is also the loss of the world's resources in the form of valuable cargoes, loss of earnings, and tragically in some cases the loss of life in what must be the most horrifying of all occurrences which can befall a seafarer.

If, in spite of all that has been said and done regarding this subject the incidence of fires does not drastically reduce, and the author is not confident that this is indicated, one must be left with the thought that a revolution is required in the recruitment, training and supervision of personnel at all levels if the lessons of previous years are not to be wasted, and the technical advances which have been made are to be properly utilised.

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The author would like to thank The Salvage Association for access to records and permission to present this paper, and also those who have given their time and assistance, but would like to point out that the opinions expressed are his own and do not necessarily reflect those of The Salvage Association.

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Discussion

G Geddes (Geddes and Partners) Many of the problems that occur are based on 'familiarity breeding contempt'.

I have attended investigations into numerous fires and could talk about same for a long time, nevertheless one problem stands out quite heavily in my mind and that is the repetitive problems occurring with the carriage of coal.

When ships were originally built for this purpose, coal was generally *heavily weathered* and had very little gas or methane content left. As a result, the then Board of Trade and their successors tended to state that the vessels were suitable for carriage of this type.

Coal then became redundant as a fuel to a great degree and less ships carried same and I understand that although consideration was being given to recording same as a 'dangerous cargo' in the manual, this was shelved.

When coal then became more favourable as a fuel, many totally unsuitable vessels were chartered to carry same.

I know of one incident where a vessel was chartered and the charterparty clearly stated, 'Not to carry dangerous or explosive cargoes'.

Whilst on charter the vessel was subchartered to another company and diverted to Canada to load a cargo of DEVCO coal. Although the Master had carried coal before, he was requested to sign, before loading, that the ship was suitable for carriage of such coal and he was advised by local surveyors, including the Government at that Port, that there was no need to 'worry in this connection'.

He nevertheless sailed and in heavy weather the No 2 McGregor hatch covers 'lifted', due to an explosion. The crew endeavoured to lash same down, which involved entering the forecastle for tools and wires and whilst in the forecastle a massive explosion took place, killing three of them.

Subsequent investigations proved that the coal in question had been directly mined and loaded into the ship, and had a very large methane content. The forecastle in question had trunking access leading from it into No 1 hold and the methane from the coal in that hold had collected in the forecastle and was obviously ignited, due to the crew's actions in obtaining the equipment needed for lashing the No 2 hatch. This caused massive damage to the forecastle space and caused the No 1 hatches to 'lift'.

Based on the above case, and many others with which I have been involved, I am of the view that coal should be strongly considered for entry into the Dangerous Cargo manual and that ships should be more strictly checked as to their suitability for its carriage.

K Harvey (The Salvage Association) Mr Geddes has a vast experience of investigating fire related casualties and I agree with his comments, especially as the cargo fire slides shown in my presentation did concern a cargo of coal. I would add that actually being seriously endangered by a fire is a sure way to concentrate the mind and learn an unforgettable lesson. For those who have never been so involved it is hoped that the contents of this paper will be read and the seriousness of the subject better appreciated.

J P P Pillai Could Mr Harvey tell us whether safety measures that are not being adhered to, for example the disposal of lighted cigarette ends, can be enforced?

K Harvey (The Salvage Association) As a Superintendent Engineer attending a tanker discharging Persian Gulf crude at Rotterdam one day the Master, Chief Engineer and myself stood at one end of the catwalk and watched a ship chandler walk the full length of the catwalk with a lighted cigar in his mouth. We were lucky, but as for a suitable punishment I am not sure what would be appropriate other than a civil action. I attended a symposium on the subject of fire safety in ships early in 1989 where a paper written by a Chinese author was read. This paper discussed the possibility of commending those persons who set a high example of safety and giving those who violate regulations some form of compulsory punishment in order to encourage an atmosphere of attention to safety. That paper stressed the need for thorough education and training. The details of the proposed method of punishment were not given. Of course lack of promotion through the various levels of employment could be a controlling factor. I would suspect that the law of supply and demand as regards replacements for those dismissed from the service would no doubt come into the equation.

P H Craig (BP Shipping Ltd) Mr Harvey's paper will be of interest not only to the shipping community, but also to historians and statisticians alike. There are, within the data provided, many figures to manipulate.

Having looked with interest at the information across the 30 year period for machinery space fires (Figs 5–9 inclusive) it is worth noting the changes in the rate of incidents. In the years 1958–65 the average is in the region of 67 per year, then for the years 1966–84 the rough average rises to around 108 per year and drops back over the period 1985–88 to approximately 50. Can Mr Harvey comment on these changes?

In the course of preparing this paper have Mr Harvey's investigations taken into consideration the introduction of UMS?

Can I suggest that the use of gross tonnage as a base might well cover up some of the facts and perhaps consideration ought to be given to the number of vessels which make up the tonnage. With the advent of the VLCC as the large box ship which replaced larger numbers of smaller tanks and the general purpose cargo ship, the use of numbers of vessels as a base might indeed show that the overall scene is more dramatic than the use of a gross tonnage base indicates.

K Harvey (The Salvage Association) Mr Craig has pointed out the apparently dramatic changes in the numbers of machinery space fires over the period reviewed. I agree that it would be interesting to have more details of the vessels making up the gross tonnages reported. However, I felt it important to maintain the same method of tabulation as has been used for well in excess of the 30 years covered by the paper, but especially as this is how the records available to me are presented. This will possibly change over the next few years but I hope in so doing the continuity with previous records will not be lost. Unfortunately it is not possible for me to separate out those vessels which are classed UMS.

Capt J Isbester (CWA Consultants Ltd) A previous contributor to the discussion suggested that, since there was no improvement in the reported incidence of fires over the years training was clearly inadequate, and higher standards of safety should be enforced by applying penalties. This would not be an effective way of improving standards. Even when people are lax in their standards they do not believe that disaster will result, so they do not fear the consequences.

The best way to encourage higher standards is by training, but such training must be provided and reinforced aboard ship. There is no use in colleges ashore teaching high safety standards to young officers if such standards are ignored by senior officers at sea. A good example must be set by the ship's senior officers, and the emphasis of any drive to improve standards must be directed to convincing senior officers of the need for high standards.

I have a question for Mr Harvey, and it concerns the use of CO_2 smothering for fires. I served aboard one ship which experienced a fire in the engine room when diesel oil overflowed from a double bottom tank sounding pipe onto the hot exhaust of a generator. The ship was in port at the time and several of the engine room staff were ashore for various good reasons. It took some 25 min to seal off the engine room and then inject CO_2 gas. This failed to extinguish the fire, which was eventually extinguished by a US Navy team using water hoses with spray nozzles.

A surveyor who subsequently attended aboard expressed the view that the CO_2 would probably have been more effective if injected earlier, before the fire was so well established, even if the machinery spaces were not at that time fully sealed. Would Mr Harvey agree with this view and would he express any view on the efficiency of CO_2 in general, since I have read of several instances of the use of CO_2 in which the fire, though damped down, continued to smoulder and was not extinguished by CO_2?

K Harvey (The Salvage Association) Capt Isbester pursues the idea of higher standards to be obtained by training. I agree wholeheartedly with this, and also that such training should be reinforced aboard ships and not filed away in the proverbial pigeon hole by such persons as mentioned by Mr Geddes who fall into the trap of familiarity breeding contempt. As regards CO_2 there is ample evidence to show that if used promptly and correctly CO_2 will smother a fire successfully. But in the case of a fire of significant size it cannot do that if the space concerned is not adequately sealed off, or if the CO_2 equipment is faulty for reasons such as partly full bottles, inoperable valves and pull wires, etc. Of course I do not know the details of the example quoted by Capt Isbester, but if sealing the engine room space was so difficult I would suspect that extinguishing the fire by an earlier release of CO_2 would depend on whether this would have been able to completely surround the fire in its early stages. If not, I feel those present would have no alternative but to pursue the line they apparently took. If personnel were working in part of the engine room, say, in order to complete its sealing off, it would be an extremely serious decision to make to commence CO_2 injection and thereby incur the risk of causing fatalities.

D W Smith (Bureau Veritas) I congratulate Mr Harvey on the data provided in his paper and note Mr Harvey's comment on a fire originating in a metal junction box. I have also observed on many occasions poor housekeeping practice on board ships where covers of distribution boxes were left loose or missing, and ships' staff should be encouraged to ensure that distribution boxes are left correctly closed after maintenance.

I would like to ask Mr Harvey if he has any comments to make with regard to the use of flammable insulation materials for electric cables and whether he has noticed any significant incidents of incorrect cable material being used.

K Harvey (The Salvage Association) I thank Mr Smith for his kind comments and for bearing witness to the appalling housekeeping habits found on various vessels attended. In the course of my research for this paper I found only the one definite case of the use of incorrect cable material. In many cases there is so much destruction that it is impossible for an investigator to find detailed evidence of any sort.

G Victory (Past President, IMarE) Mr Harvey demonstrates in this paper that the twin problems of fire and explosion on ships are ever with us. He provides a great store of statistics and some case histories for such casualties ranging from 1958–1988, and from them he concludes that 'Fires involving ships of all types occur in significant numbers and there is no encouragement to believe that a dramatic reduction can be envisaged' (p 17). What an admission of defeat.

Yet, on p 26 he says that 'Extensive research and development has taken place' and that 'Vast improvements have been made ... as regards ship design, materials of construction, early warning systems, safety and firefighting systems.' What he does not explain is why there has been no commensurate improvement in the casualty figures. He seems to be rather satisfied to explain it all away on 'human error, negligence, lack of maintenance of the ship and equipment' and 'failure to follow the lessons of past experience', and I must agree that these factors are often brought to light in casualty reports – perhaps too often. But what about original design faults in piping and machinery, management directives which pressurise personnel to adopt suspect operational procedures in the interests of saving time and money – particularly money? It is not always stressed that 'human error' is not restricted to the ship's personnel.

On p 17 Mr Harvey stresses that over the 30 years covered 'The design of each vessel ... together with the materials of her construction and equipment on board, complied with the contemporary rules and regulations of the authorities concerned, including those of the Classification Society concerned'. Perhaps he does not give the 'authorities' a capital 'A' because many of the ships dealt with in 1958 were built for and operated under national flags which had no national rules or enforcement organisation for the simple reason that, in respect of the load line and stability convention, there were no international agreements on standards of safety, in respect of fire and machinery, in force for ships built before the coming into force of the 1948 convention. I believe this was 1952 for most, but not all, countries.

A colossal amount of work has been done at IMCO (and its successor IMO), which incidentally did not exist in 1958, to improve safety regulations – especially for cargo ships and tankers in the intervening years, as anyone who looks at the 1948 convention rules and compares them with the present international rules will soon realise. Mr Harvey recognises this in his conclusions. What he does not do is to explain why these improvements have not been accompanied by a fall in the number or severity of casualties. His case histories as they are do not give many clues as to how they can be improved except by references to poor or careless operational procedures. But human nature was the same in 1958 as in 1988 so we should perhaps look for other reasons. These could be found in the construction, management procedures and the manning and operating of vessels as they were in 1958 and as they are now. Such things as reduced scantlings, a change from general cargo to bulk and more hazardous cargo, a relaxation in some tonnage requirements or a less than adequate increase in scantlings for very large ships, together with a greater emphasis on keeping up to schedule even if it means going through a storm instead of avoiding it or even turning back, could well have influenced the casualty statistics in non-machinery space areas. But that is in other hands.

What I am concerned with, and what Mr Harvey does nothing to bring out, is what can be done to improve the position in respect of machinery and machinery spaces, except in respect of training and education and improved supervision and safe operational practices, all of which I heartily endorse. But I would suggest that much could be done in the design and arrangement of machinery spaces to take account of the differences between 1958 ships and the present ships, with their so called modern improvements. Mr Harvey says that 'More outbreaks of fire occur in machinery spaces than anywhere else, frequently due to a spray of fuel oil, or luboil, impinging on a hot surface and igniting' – so let us study this. Modern ships have high fuel pressures and are smaller, with a greater concentration of engines, generators, auxiliary boilers, fuel treatment equipment and other 'hazardous' equipments, such as superchargers, than the traditional ship had. This is mainly due to the dropping of the 17% engine room allowance criteria to give tonnage exemption for the machinery spaces, so it behoves us to see that oil has less chance of leaking or impinging on hot surfaces than is presently the case. It took a great deal of effort to overcome the opposition to the IMO requirement that injection pipes on diesel engines should be double walled with the annular space drained to a safe space, and in my opinion this requirement could well be extended to other pressurised fuel pipes in areas where spraying would be particularly hazardous. At least such pipes should be well screened in such areas with the proviso that any drips should be to a safe place.

Despite all protestations the unmanned engine room is not as well protected against the onset and detection of fire as the older engine room, properly supervised at all times by a properly qualified Engineer Officer. 'Time is the essence' in a fire situation and not all alarms will quickly detect the onset of fire in a remote area, whilst the response by personnel, particularly at night when they may be in bed, can very often give the fire those few precious minutes between one which is easily dealt with or one which, to put it bluntly, is a 'ruddy' conflagration. So, in unmanned engine rooms, the detection and extinction arrangements should be better than those required by the 'minimum' IMCO and classification requirements. For example, all leakages or overflows should be led safely to a tank or receptacle with a high level alarm – including those from double walled pipes and tundishes – and arrangements to shut off all machinery and ventilation and to shut all closing arrangements rapidly should be grouped in a safe area with the main fire extinguishing system for rapid response, whilst personnel should be informed by management that no delay should be allowed between the detection of a fire and the stopping of machinery, isolation of the space and use of main fixed fire extinguishing systems where local fire fighting is difficult. One should never have to 'fight' a fire – it should be overwhelmed.

Perhaps we should take a good look at the 'compression fitting' type of pipe connection for use on oil pipes under pressure. Such fittings, often used on gauge pipes, are subject to pulling out at the ends, particularly where vibration is present – and there is plenty of that on ships. Few marine engineers know exactly how much tightening is required for the best grip. Too little and the internal pressure will eventually cause the pipe to come out of the fitting; too much and the olive will neck the pipe and lead to circumferential fracture. If their use is not banned should they only be used when fitted with extra stops to prevent the pipe moving endways out of the fitting? Attention should also be paid to providing extra support for oil pipes under pressure; too often we see them sagging or vibrating between supports. So much for oil pressure pipes – and they are only one aspect of the machinery space fire hazard, though perhaps the most vulnerable.

Too often engineers think that they should not stop the engines or shut down the engine room without giving the bridge adequate notice. This mental attitude should be altered. After all a major engine breakdown or blackout would stop everything without notice so why introduce a delay which could be fatal when a fire is detected?

And finally, perhaps with tongue in cheek and despite all that IMCO has done in respect of 'in-port' inspections, is the standard of statutory and classification survey and supervision as good as it was 30 years ago? In the UK the marine survey service has been emasculated – there are many fewer surveyors in the field but no shortage of administrators. Two of the busiest ports, Dover and Harwich, still have no survey office or surveyors resident near enough to the port to really supervise the ferry service or to know just what is going on, whilst other ports whose trade has greatly declined still have their survey offices. And so to Classification Societies; in 1958 there were but a few, all tied to some extent to a major marine nation with high standards and little competition. In 1988, and despite the formation of the Association of Classification Societies – a good thing in itself, we have many more, some of dubious ancestry, and a great deal more competition for fewer ships, which leads to unsafe practices. We have, for some time, been at the mercy of 'flags of convenience' – are we now to be at the mercy of 'Classification Societies of convenience'?

There is much yet to do unless we are to be satisfied that the frequency of fires in ships, which has persisted since 1958, is one we can and must live with. I, for one, am not.

K Harvey (The Salvage Association) Mr Victory's comments at question time are always received with respect and it is gratifying to note that his written contribution conveys a substantial measure of agreement to the statements contained in the paper. He agrees that fires/explosions are a continuing presence and this is factual. He agrees that vast improvements have been made in the various areas described in the paper over the period reviewed. This is also factual. No doubt these improvements stemmed in no small measure from the substantial British Flag interests and MOT teams in earlier years and IMCO/IMO teams more recently. The records as regards British Flag vessels speak loud and clear for themselves and need no support from me, although I willingly give it. I cannot however seriously believe that Mr Victory is correct when he talks of defeatism. As Marine Engineers it is our bounden duty to make every effort to increase our knowledge and advance all aspects of the science, not least of all in the sphere of fire safety aboard ship, convincing our higher authority of the financial and moral strength of the proposals we put forward. The purpose of my paper was not to paint a picture of despair but it will hopefully provide to the international reader a record with which future results may be compared, show the current state of fire safety aboard ship on a world-wide basis as depicted by the results recorded to date, and provide a useful opinion in a professional and unemotional manner of the way ahead. Mr Victory's discourse has embellished in some detail various measures that could usefully be adopted to improve the existing fire/explosion status within the industry, and I do not disagree that more effort is required from the international community involved. It is to be hoped that if there was a definite method of dramatically reducing the number of fire/explosion tragedies in the past it was not simply overlooked by all those interested parties who have served on Flag, MOT, IMCO, IMO and Classification Society teams over the last 30 years or more.