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THE SWEDISH CLUB HIGHLIGHTS

JULY 1998

Main engine damage

This is the complete text of a paper that was presented by the Club's Loss Prevention Officer, Martin Hernqvist, at the 22nd CIMAC Congress in Copenhagen 18-21 May 1998.
The paper was also the starting point of a loss prevention programme initiated by the Club to tackle the cause and consequence of main engine damage.

ABSTRACT

The purpose of this paper is to show engine manufacturers that damage to the main engine is a comparatively large problem for shipowners – it is expensive, the frequency of damage is high and the consequences may be severe. A second objective is to create an increased awareness amongst shipowners of main engine damage and to assist them in identifying target areas.

Important findings in the study are that main engine claims amount to 16.9% of the number and 11.5% of the cost of all hull & machinery claims. Medium speed engines are over-represented in the claims files. The average claims cost per year is five times as high for a medium speed engine than for a low speed engine. The most common types of claims for medium speed engines are, in order of frequency, damage to turbocharger, crankshaft/connecting rod and exhaust valves/pushrods.

Nearly half of the number and cost of claims for low speed engines are damage to turbocharger.

Newer engines do not produce a better result than older.

INTRODUCTION

The Swedish Club is a mutual marine insurer – owned and controlled by its shipowner members. The Club writes hull & machinery, war risks, P&I, loss of hire, FD&D insurance and any other additional insurances required by shipowners. Being owned by its members, it is natural that a priority area for the Club is the prevention of accidents and claims. The Club has a separate department dealing with these issues – the Loss Prevention & Technical Department. The main tasks for the department are surveying ships, carrying out damage surveys, performing claims analyses and informing members about the outcome of these analyses. Whenever possible, when good advice and solutions are at hand, the Club issues recommendations or initiates loss prevention programmes aiming at preventing the recurrence of accidents.

The Club was pleased to receive an invitation to participate in the 22nd CIMAC Congress in Copenhagen and be given the opportunity to present its experiences of main engine damage to such a wide audience. To many delegates at the Congress – the experts from the industry – some of the statistics revealed may not be news. To many of the shipowners' representatives, people who have experienced perhaps just a few main engine accidents, the statistical data may be of greater interest and use. The Club believes that an increased interest and awareness amongst shipowners may put pressure on the manufacturers – enlightened customers will be demanding customers requiring more assistance in the prevention of costly accidents. The Club is certainly more than willing to assist in achieving this and the Club's unique position of being able to gather data, involving a variety of vessels and engine types, is naturally of great help.

The focus in this paper is to identify trends and patterns rather than to present the possible remedies to the problems. The Club is wise enough to realise that the expertise in this area exists with the researchers and manufacturers and will therefore refrain from offering specific advice at this occasion.

In 1995, the Club published a study on main engine damage between the years 1988-1994. Readers of that study will recognise some of the graphs, facts and figures. All figures have, however, now been updated and the years 1995-1997 included.

A typical comment on the previous study was that as matters ought to be continuously improving, the outcome would have been different if the Club had focused on claims from recent years separately and not just the period 1988-1994 as a whole. As a response to that comment, in this study, data from the years 1995-1997 have been compared separately with data from the years 1988-1994. A sim-

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ilar pattern would confirm previous results. The comparison would also provide an answer to the question if things really have improved and whether modern engines are more reliable than old ones.

BACKGROUND DATA

This study is based on hull & machinery claims between 1988-1997 (as per January 7, 1998) where the Club made payments of USD 10,000 or more. The deductible is added to the cost of the claim in order to obtain the total cost of damage. In those cases where The Swedish Club did not cover 100% of the ship's value, the claims figures are recalculated to correspond to a 100% coverage. The claims figures are adjusted to the 1998 price level using the Bureau of Labor Statistics Data's Consumer Price Index.

Worth noting is the fact that damage which falls below the deductible is in most cases not brought to the Club's attention. The amount of damage that affects the shipowners is consequently greater than that shown in this study. The average deductible in 1997 for hull & machinery claims was approximately USD 100,000 for an 'average' vessel.

Differences in figures for the years 1988-1994, between this study and the Club's study from 1995, are due primarily to the fact that cases that were still 'open' in 1995 have now been finally settled.

The Swedish Club does not claim that the results of this study necessarily would have been the same if all main engine damage world-wide had been analysed.

HULL & MACHINERY CLAIMS

Initially, it is important to place engine related claims in their context. Is engine damage a comparatively large or small problem for the shipowners? Well, as the cost of insurance reflects the cost of the accidents, the cost of insurance reflects the size of the problem. This is true for P&I clubs and mutual hull clubs since these clubs seek to achieve a balance between premiums and claims. In spite of occasional 'soft' insurance markets, in the long run shipowners will have to pay for the accidents that occur. For many shipowners the cost of insurance is the second largest item in the vessels' operating costs next to crew costs. In other words, insurance costs are high. A rough figure indicates that 2/3 of the insurance costs are for the hull & machinery cover – damage to hull, machinery and ship's equipment.

Figure 1 shows the distribution of The Swedish Club's hull & machinery claims.

According to the graph, 38% of all claims handled by the Club are related to machinery. There is a big jump to the next most common type of claim, contact damage, which amounts to 15% of all H&M claims.

The picture is somewhat different when the claims are divided by cost (figure 2). It is obvious that fire/explosion, heavy weather, groundings and collisions are the most expensive types of claims. Compared to figure 1, where the claims were divided by number, the proportion of these claims has increased. The proportion of machinery related claims is, however, still the largest.

Figure 1. ***Hull & machinery claims by number, 1988-1997.***

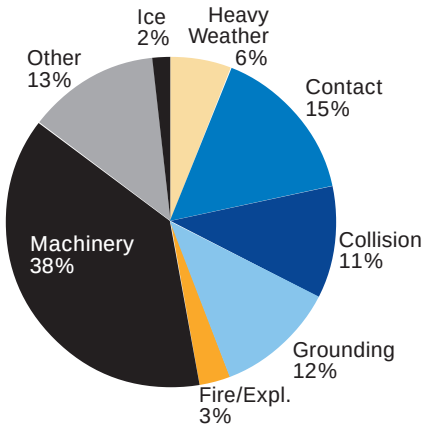
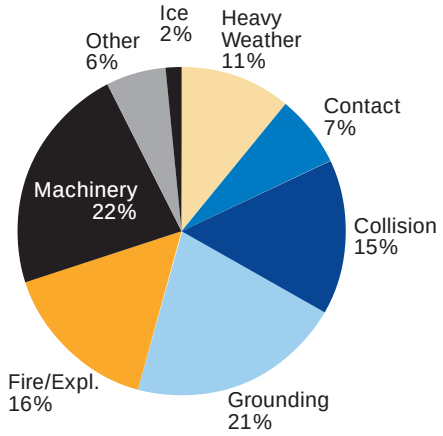


Figure 2. ***Hull & machinery claims by cost, 1988-1997.***



The total number of claims between 1988-1997 amounted to 1,681. The total cost was nearly USD 700 million and the average cost for all types of claims was USD 415,000. Data of the individual claims types are found in table 1.

Even though the frequency and cost of claims are high, the trend is clearly downward. Figure 3 illustrates the number of vessels covered for H&M along with the number of H&M claims each year.

The downward claims trend, as illustrated in figure 3, is most likely explained by increased awareness of safety matters among the Club's members together with a general increase in deductibles in 1991.

Figure 3 tells us that 521 vessels produced 233 claims in 1988 compared to 131 claims produced by 672 vessels in 1997.

On average, every second ship reported one claim a year in the first three-year period, 1988-1990, compared to every fifth ship in 1995-1997.

MACHINERY CLAIMS

As previously shown, machinery claims form the largest part of the H&M claims. Machinery claims are claims related to main engines, auxiliary engines, steering gears, boilers and propulsion. Propulsion damage in this context is damage to propeller, propeller shaft and bearings etc.

As shown in table 2, 45% of the number and 51% of the cost of machinery claims are damage to the main engine. Boiler damage is the most expensive type of machinery claim, USD 358,000 on average.

Claims type	Number	Total cost (USD)	Avg. cost (USD)
Heavy weather	99	74,775,232	755,305
Contact	260	49,923,716	192,014
Collision	185	106,507,560	575,717
Grounding	198	147,281,406	743,845
Fire/Explosion	54	109,229,176	2,022,763
Machinery	636	157,819,551	248,144
Other	216	39,933,427	184,144
Ice	33	11,452,028	347,031
Total:	**1,681**	**696,922,096**	**414,588**

Table 1. *Hull & machinery claims, 1988-1997.*

Claims type	Number	Total cost (USD)	Avg. cost (USD)
Main engine	284	80,425,624	283,189
Steering gear	38	9,398,590	247,331
Aux. engine	193	33,555,608	173,863
Boilers	59	21,112,169	357,833
Propulsion	62	13,327,560	214,961
Total:	**636**	**157,819,551**	**248,144**

Table 2. *Machinery claims, 1988-1997.*

MAIN ENGINE CLAIMS

The main engine claims, which have cost the Club's members over USD 80 million over the last ten years, will be focused on for the remaining part of this paper. The main purpose is to find trends and patterns – patterns that may identify areas to give priority to in the work to prevent future claims and losses.

Figure 3 indicated a downward trend in hull & machinery claims in general. What about the trend in main engine claims?

Figure 4 is a graph similar to figure 3. The trend in main engine claims follows the general trend in H&M claims – in relation to the number of vessels insured, slightly more than a twofold improvement over the last ten years. (Note that these are major claims – claims exceeding the deductible by USD 10,000 or more. See background data.)

Claims by engine type

In its main engine damage study from 1995, the Club presented some rather remarkable results from an analysis of claims divided by main engine type – low speed (LS), medium speed (MS) and steam turbine (ST). From figure 5, which is a diagram from the previous study, it can be seen that medium speed engines were producing claims far beyond their share of the Club's fleet.

It would be interesting to see if the claims from the years 1995-1997, which were not included last time, show a pattern similar to the one in figure 5.

Even though the statistical data from the years 1995-1997 are small compared to data from the years 1988-1997 (73 claims compared to 211), the patterns in figures 5 and 6 are very similar. The proportion of low speed engines in

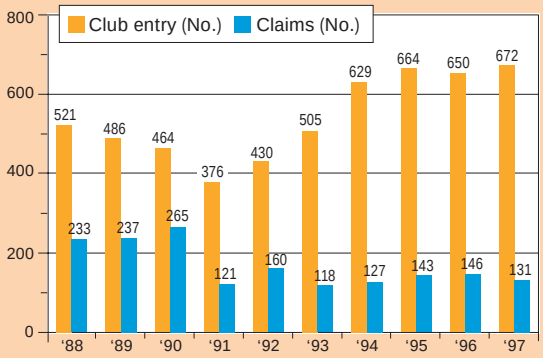


Figure 3. *Club entry and number of H&M claims.*

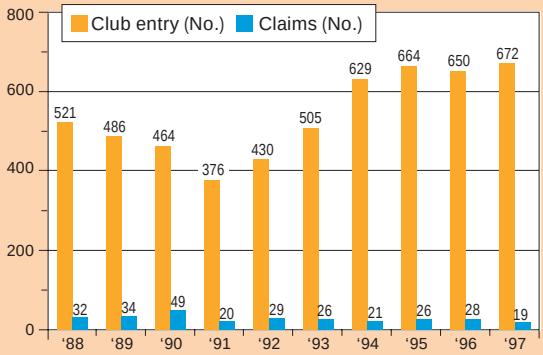


Figure 4. *Club entry and number of main engine claims.*

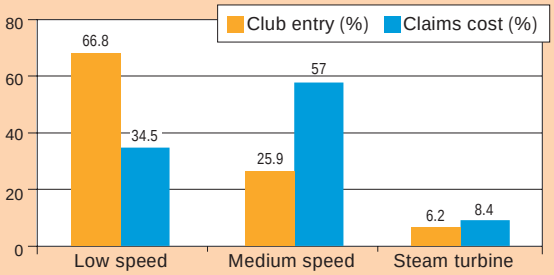


Figure 5. *Percentage of Club entry and claims cost by engine type, 1988-1994.*

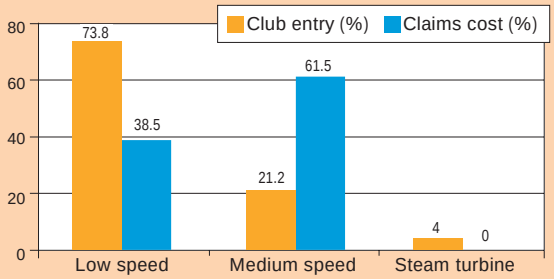


Figure 6. *Percentage of Club entry and claims cost by engine type, 1995-1997.*

the Club's fleet has increased slightly. So has the proportion of claims produced by the low speed engines. The proportion of medium speed engines has decreased a little but their proportion of the claims has gone in the opposite direction.

The Club did not receive any major claim on steam turbine engines during 1995-1997.

Faced with the differences in claims results between the engine types, as shown in figures 5 and 6, the Club carried out an analysis of the individual makes. The purpose was to see if the individual makes followed the general pat-

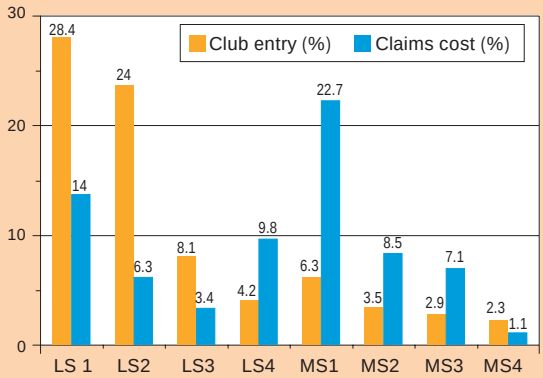


Figure 7. ***Percentage of Club entry and claims cost by engine make, 1988-1994.***

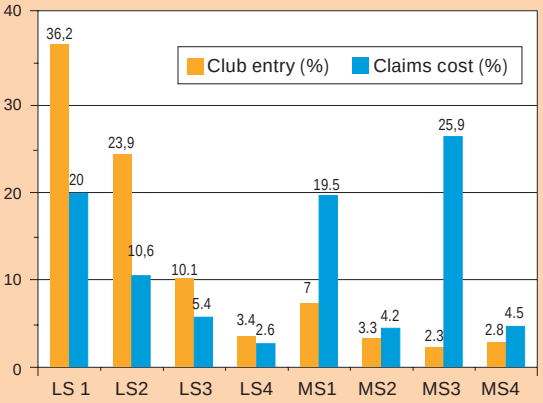


Figure 8. ***Percentage of Club entry and claims cost by engine make, 1995-1997.***

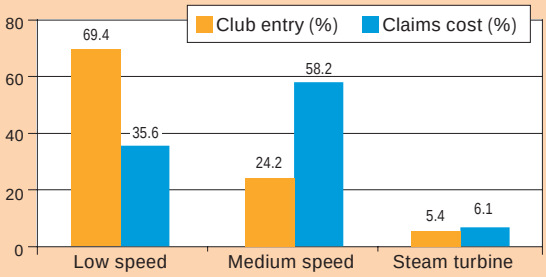


Figure 9. ***Percentage of Club entry and claims cost by engine type, 1988-1997.***

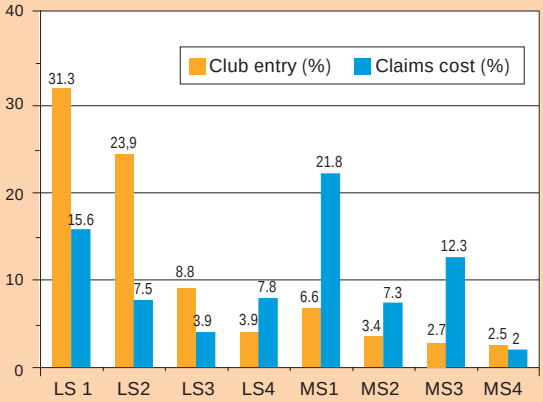


Figure 10. ***Percentage of Club entry and claims cost by engine make, 1988-1997.***

tern. Figure 7 shows the four most common low speed engines in the Club's fleet together with the four most common medium speed engines. The name of the make is protected by a three-character code, LS1-LS4 for low speed engines and MS1-MS4 for medium speed engines. The identity of the makes is, however, available to the Club's members. Engine manufacturers will also be informed about the code that represents their make.

As for figures 5 and 6, the engine make analysis was carried out separately for the years 1988-1994 and 1995-1997. The 1995-1997 analysis is shown in figure 8.

The patterns, 1988-1994 and 1995-1997, are again very similar. Medium speed engines are over-represented in both periods. The pattern is valid, with few exceptions, for all engine makes. Results that deviate are the claims record for the low speed engine LS4 between 1988-1994 and the claims record for medium speed engine MS3 between 1995-1997. Such deviations usually have explanations rather than being coincidences but when studying these claims further no clear picture emerges from the LS4 claims files. This engine make is just more represented in the files both by frequency and cost of claim. For MS3, however, many claims refer to a specific type of failure that hit one of the Club's members who had a large fleet equipped with this type of engine. The engine manufacturer in question reacted to the problem and made changes to the design.

Figures 9 and 10 contain data from the whole period, 1988-1997.

Another way of illustrating the cost of main engine claims by engine type is shown in figure 11. Figure 11 shows that a vessel equipped with a medium speed engine, on average, suffers a cost of USD 36,000 per year for damage related to the main engine. This cost is twice as high as for a steam turbine equipped vessel and nearly five times as high as for a vessel equipped with a low speed engine. (Note! These costs do not include the costs of damage below the deductible. The actual yearly average costs are consequently higher. See background data.)

Age of engine at time of accident

One might believe that newer engines are more reliable than older. It is rather difficult to prove this unless the statistical data is large. Previous graphs have indicated that there is a difference between low speed and medium speed engines regarding the cost of claims. Accordingly, this analysis was divided into these two groups.

The claims data in figures 12-15 is divided by number instead of cost. This is especially important for figures 14 and 15 (claims between 1995-1997) where the number of claims is small. The picture could be completely distorted by a single high-cost claim if the division had been made by cost. The actual number of claims is stated above each column.

Figure 12 shows that nearly 30% (41 of 139) of the low speed engine claims were caused by relatively new engines, up to and including engines of four years of age. This age group, 0-4 years, constituted 20% of the low speed engines in the Club's fleet.

The age group 5-9 years is also over-represented in the claims files.

The frequency of medium speed engine claims by age is

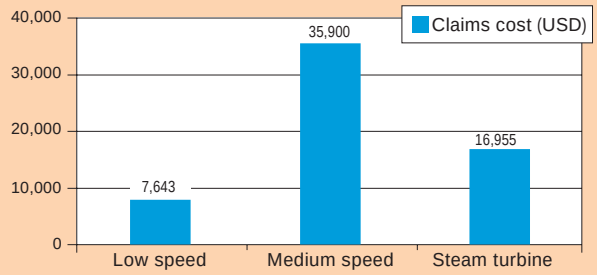


Figure 11. ***Average cost for main engine related claims per year and vessel by engine type (USD).***

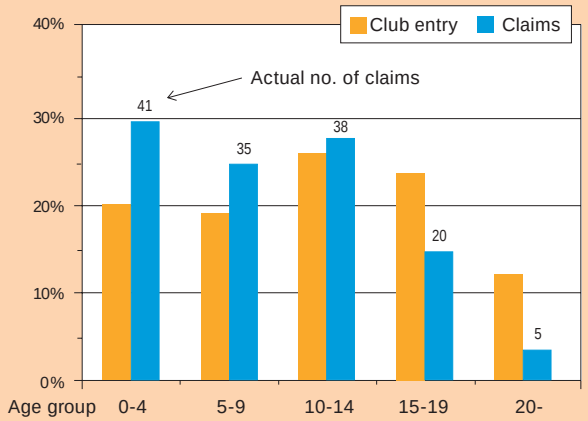


Figure 12. ***Distribution of claims by age of engine, low speed engines, 1988-1997.***

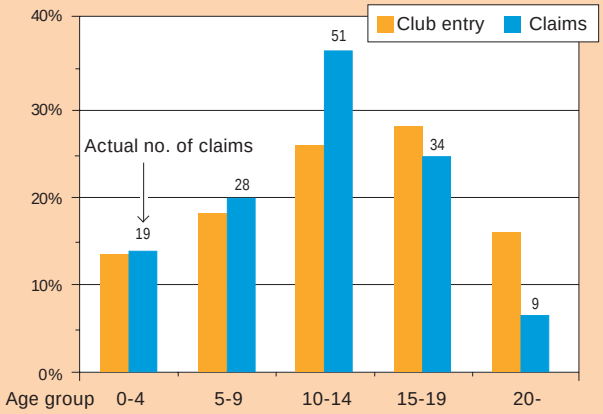


Figure 13. ***Distribution of claims by age of engine, medium speed engines, 1988-1997.***

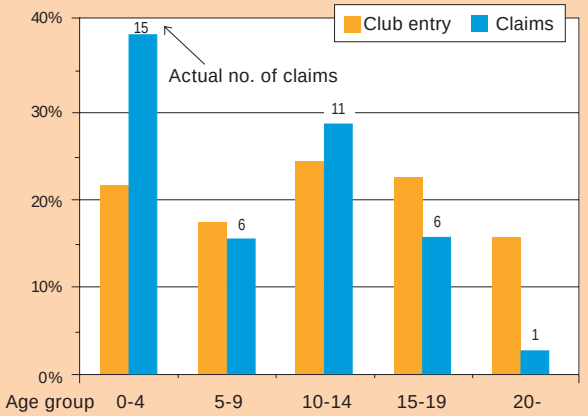


Figure 14. ***Distribution of claims by age of engine, low speed engines, 1995-1997.***

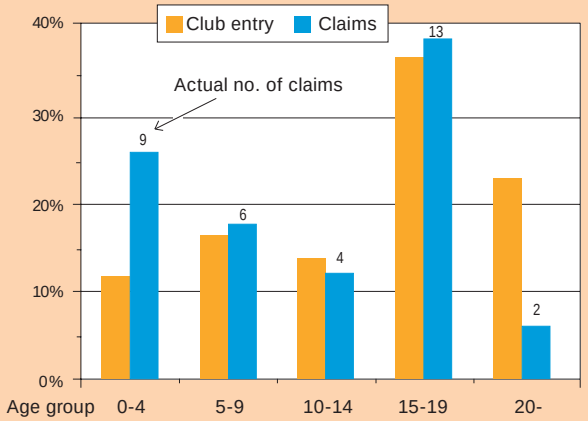


Figure 15. ***Distribution of claims by age of engine, medium speed engines, 1995-1997.***

shown in figure 13. Most claims are caused by engines between 10 and 14 years of age.

The figures 14 and 15 are included in this paper to see whether engines manufactured in the 1990s show better results than older engines. As the period in these figures stretches over the years 1995-1997, engines manufactured sometime between 1991-1997 will be found in the age group 0-4.

The Club received 39 low speed engine claims between 1995-1997. Almost 40% of these were caused by engines manufactured in 1991 or later. Even though the statistical data is small, it is a fact that 15 claims were caused by these modern engines. The number of claims should have been eight to correspond to the proportion of these engines in the Club's fleet.

Of the 15 claims in age group 0-4, ten were for damage to turbocharger. The remaining five were for crankcase cracking, cracks in columns, damage to torsion vibration damper, damage to governor and cylinderliner damage.

The majority of the medium speed engines between 1995-1997 was of 15 years of age or more. The age distribution is the major difference between figure 14 and figure 15 – the low speed engines were more equally distributed over the age groups. The most important similarity is that new engines are over-represented also for medium speed engines, 9 of 34 claims. In this case, the number of claims should have been four to correspond to the proportion of these engines in the Club's fleet.

Of the nine claims in age group 0-4, four were for damage to turbocharger. Three were for exhaust valve failures, one was for gearbox damage and, finally, one for crankshaft damage costing USD 2 million.

The exhaust valve failures, averaging USD 360,000, hit different ships but the same engine model. Most probably ships insured elsewhere equipped with this engine model have experienced the same problem as The Swedish Club and its member did. A quick response from the engine manufacturer could very well have prevented some of these costly accidents. The engine make in question is the same as MS3 from figure 8. As previously mentioned, the manufacturer reacted to the problem but, as can be seen from figure 8, built up a poor claims record before changes to the design were made.

Types of main engine claims

The following three tables, tables 3-5, show the most common types of main engine claims. The percentage figures in table 3 are the shares expressed in percentages of all main engine claims, i.e. 284 claims totalling USD 80,425,624.

The average costs in these tables are rather high. This is primarily explained by the fact that the study is based on major claims. In addition, there have in some cases been consequential damage, affecting other parts of the engine, of which the costs have been included in the total cost of claim. This appeared to be especially common for damage to piston/piston rod.

Damage to turbocharger is by far the most common type of main engine claim.

Divided by cost, damage to turbocharger is still in first place, followed by damage to crankshaft/connecting rod and damage to journal/bearing.

The percentage figures in tables 4 and 5 are the shares expressed in percentages of all of the claims involving the engine type in question. For example, low speed engines produced 139 claims between 1988-1997. 65 of those, or 46.8%, were damage to turbocharger. These were followed by damage to cylinderliner and journal/bearing. The figures are found in table 4.

Also for medium speed engines, damage to turbocharger is in first place. This is followed by damage to crankshaft/connecting rod and damage to exhaust valves/pushrods.

Damage to crankshaft/connecting rod and damage to journal/bearing damage are very expensive. Crankshaft/connecting rod damage costs, on average, as much as a grounding.

Causes of main engine claims

Traditionally, underwriters have focused on the extent of damage and whether and to what extent the damage is covered by the insurance conditions rather than investigating for the cause of damage. This explains why insurers sometimes lack detailed information on causes of damage. The Club's experience is also that in many cases it is difficult to find the exact cause of damage as there is often a chain of events including both technical and human errors. However, thanks to increased commitment to loss prevention, the causes of damage have become increasingly important and, in the future, many insurers will have more information on the causes of accidents stored in their databases.

Damage to turbocharger, however, which is the most common type of main engine claim, is according to the Club's experience most often caused by:

1. A foreign object has passed through the turbine. Typically, this foreign object is a piece of an exhaust valve, piston ring or expansion bellows.
2. Leakage of cooling water from the turbine casing into the turbine. This is more common on older than newer vessels. Shipowners should beware as this type of damage is often caused by 'wear and tear' and, consequently, is not covered by the insurance conditions.
3. Lubrication problems – low lubrication oil level or dirty oil.

Claims type	Number	Total cost (USD)	Avg. cost (USD)
Turbocharger	93 (32.7%)	17,141,111 (21.3%)	184,313
Cylinderliner	33 (11.6%)	5,584,293 (6.9%)	169,221
Journal, Bearing	28 (9.9%)	14,161,248 (17.6%)	505,759
Crankshaft, Con. rod	23 (8.1%)	16,994,466 (21.1%)	738,890
Piston, Pistonrod	21 (7.4%)	7,065,604 (8.8%)	336,457
Exhaust valves, pushrods	20 (7.0%)	3,505,481 (4.4%)	175,274
Fuelpump, gears	14 (4.9%)	2,125,304 (2.6%)	151,807
Reduction gear	9 (3.2%)	5,100,582 (6.3%)	566,731

Table 3. ***The eight most common types of claims (all engines).***

Claims type	Number	Total cost (USD)	Avg. cost (USD)
Turbocharger	65 (46.8%)	13,209,918 (46.1%)	203,230
Cylinderliner	26 (18.7%)	4,305,141 (15.0%)	165,582
Journal, Bearing	11 (7.9%)	3,665,032 (12.8%)	333,185
Piston, Pistonrod	8 (5.8%)	1,682,177 (5.9%)	210,272
Fuelpump, Gears	5 (3.6%)	1,038,687 (3.6%)	207,737

Table 4. ***The five most common types of claims (low speed engines).***

Claims type	Number	Total cost (USD)	Avg. cost (USD)
Turbocharger	28 (19.9%)	3,931,193 (8.4%)	140,400
Crankshaft, Con. rod	22 (15.6%)	16,363,816 (34.9%)	743,810
Exhaust valves, Pushrods	20 (14.2%)	3,505,481 (7.5%)	175,274
Journal, Bearing	17 (12.1%)	10,496,216 (22.4%)	617,424
Piston, Pistonrod	13 (9.2%)	5,383,427 (11.5%)	414,110

Table 5. ***The five most common types of claims (medium speed engines).***

GENERAL RECOMMENDATIONS

It is difficult for the Club to give specific advice to shipowners on measures to prevent main engine damage since these accidents are often connected to a specific type of engine make and model. However, based on the Club's experience, general recommendations include:

1. Maintain the engine room crew intact as much as possible. A crew well-trained and familiar with the engine is a key factor in respect of safety.
2. Implement a planned maintenance system and ensure that this is continuously kept up-to-date.
3. Use only spare parts from reliable suppliers.
4. Ensure that filters and purifiers for lubricating oil are in sound condition. Take samples of the lubri - cating oil. The quality of the oil should be carefully monitored and tested enabling change of oil before damage occurs.
5. The above is valid also for fuel oil. Ensure that the oil is in accordance with the engine manufacturers specifications.
6. Monitor engine performance. Ensure that all alarm and shut-down systems are functioning.
7. Follow manufacturers' instructions, service letters and the like. Contact the manufacturers after change of address, change of ship management, etc. to ensure that they have the correct mailing address.
8. Take measurers to minimise the risk and consequences of engine room fires. These measures include inspection of cleanliness in the machinery spaces, the condition of pipes and fittings, the insulation/lagging of hot surfaces, the operation of quick-closing valves, fire dampers, etc.

   (Even though engine room fires have not been dealt with in this study, the Club does not want to leave out this issue. A number of accidents coded *fire/explosion* were initially caused by problems related to the main engine. More information on the Club's Engine Room Fire Prevention Programme can be obtained from The Swedish Club's office in Göteborg, Sweden.)

Sufficient funds must be supplied to comply with high standards of safety and quality, but, needless to say, this is a worthwhile investment.

It should be noted that failure to follow some of the above recommendations may be a breach of the ISM Code requirements. Section 10 of the Code says: "The Company should establish procedures in the Safety Management System (SMS) to identify equipment and technical systems the sudden operational failure of which may result in hazardous situations. The SMS should provide for specific measures aimed at promoting the reliability of such equipment or systems. These measures should include the regular testing of stand-by arrangements and equipment or technical systems that are not in continuous use." These measures should be integrated into the ship's operational maintenance routine.

Failure to comply with the ISM Code requirements may jeopardise insurance cover.

CONCLUSIONS

From a marine insurers point of view, the following should be remembered with regard to main engine damage:

1. Damage to the main engine is a large problem for shipowners - it is expensive and the frequency of damage is high. Medium speed engines need extra care. These engines are over-represented in the damage statistics, more or less independent of the make.
2. The consequences of a main engine damage may be severe. Main engine breakdowns are a potential threat to people, the ship, its equipment and cargo as well as the environment.
3. Do not trust new engines just because they are new. The statistics show that new engines, as for many other industrial products, have teething troubles.
4. Initially, focus on the most frequent and costly types of damage. For low speed engines, the causes of turbocharger, cylinderliner and journal/bearing damage should be given priority. For medium speed engines, the causes of damage to crankshaft/connecting rod, journal/bearing, piston/pistonrod and turbocharger should be highest on the agenda.
5. Different engines experience different problems. The most complete and accurate information about failures related to a specific engine is gathered by the engine manufacturer. The shipowners are therefore, compared to most other types of claims, to a larger extent in the hands of people outside their own organisations. The recurrence of accidents may very well be blamed on insufficient information from, and lack of preventative steps by, the manufacturers. There is certainly scope for manufacturers to increase their efforts in assisting customers in the prevention of accidents.

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