IMIA Conference

Potential Impact of Aging Plant and Equipment on Machinery Breakdown Insurance:
Power Generation Database:
July 1999

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Versailles, France
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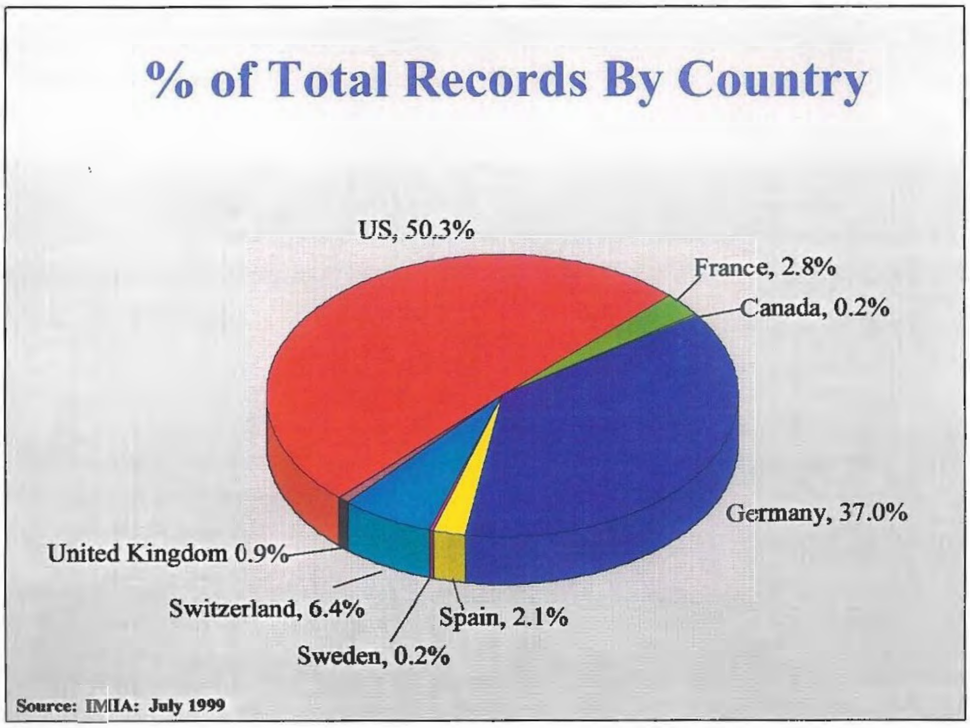
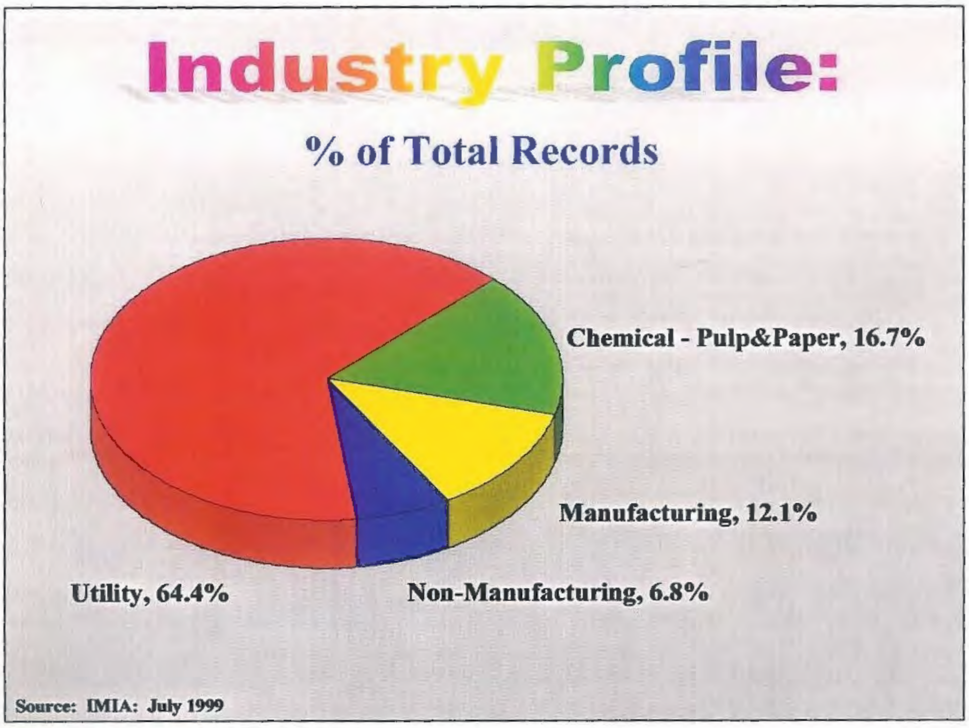
Slide 1

Good morning, lady and gentlemen. I'm very pleased to present our update as a result of the most recent data call from all of the delegations. Thank you all very much for your participation. We will be talking just about the update and not about the entire database, but I do want to underline the importance of letting everyone know that this database is now getting to be of such a size that it is very valuable, and I know of no database in the world like it. I'll talk more about that as we proceed.



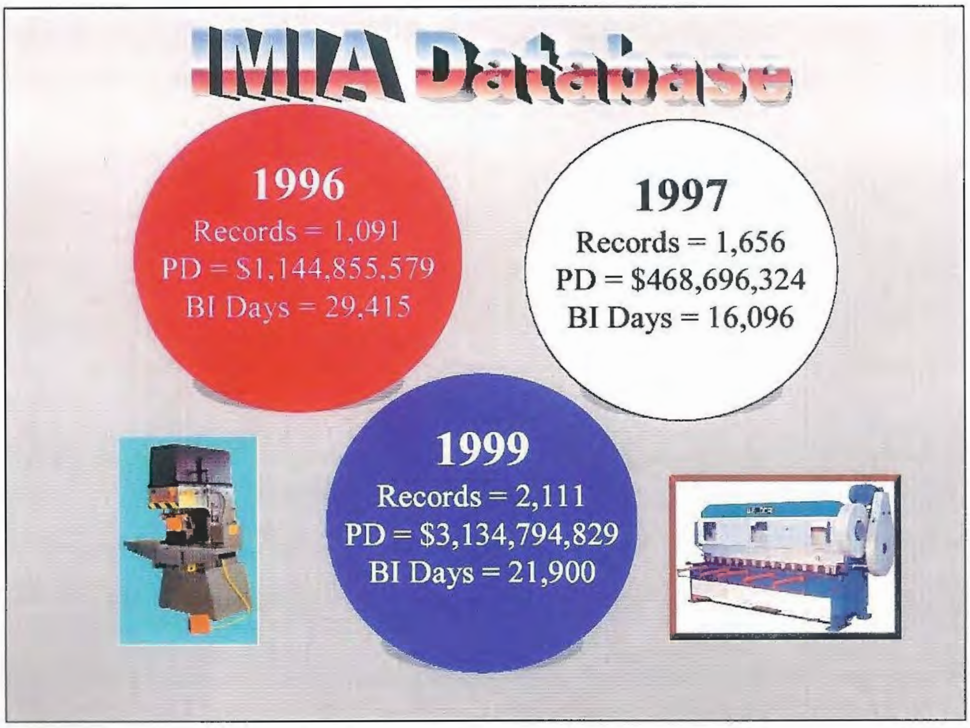
Slide 2

This is a pie chart showing the representation of the records contributed by country. Not all countries are shown because we couldn't round up some of them to up to a significant decimal place, but I do want to point out that it is encouraging that the percentage represented by the U.S. database is shrinking from previous years, when we were about 60%. Also, it's good to see certain other countries being more significant, most notably Germany. Some countries we know have a lot more information, and we'll be talking to them about trying to obtain it.



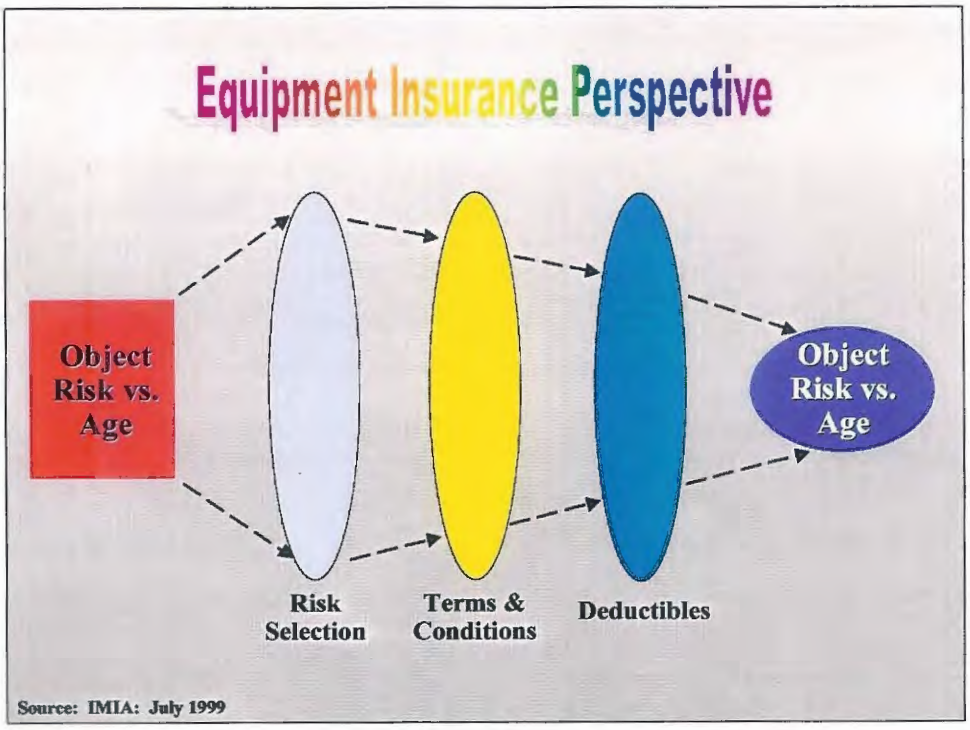
<u>Slide 3</u>

This is a profile of the industry groups represented in the recent update, from the 2100+ records we received. As you can see, Utility or Power Gen related industry is still the bulk of the data, but we are picking up Manufacturing classes such as Chemical, Pulp & Paper, general manufacturing, and also some non-manufacturing. This is giving us a very broad-based global database in a wide range of industry groups.



Slide 4

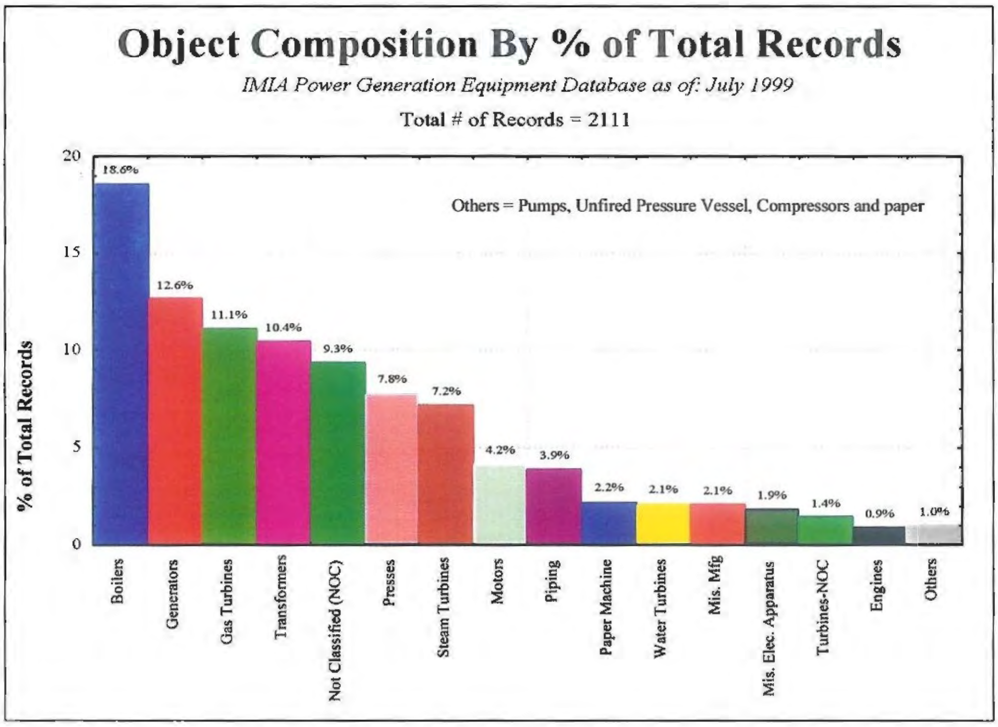
This is the total IMIA database. If we look to when we started in 1996, there were roughly 1,000 records for $1.1 billion in physical damage losses and roughly 29,000 days of Business Interruption loss. In 1997, we again updated and received an additional 1600 records, etc., and in 1999, we received another 2100 records. The total, if we add all three of these together, in terms of our databases, is we have roughly 4,858 claims in the database representing $4.7 billion U.S. dollars in physical damage losses and roughly 157 years of Business Interruption outage. Again, let me caution you that the Business Interruption is the most incomplete information in our files, but to have a database of this magnitude on a global perspective is truly amazing and is a very powerful tool. We'll be talking about our proposal to further analyze the entire database as we progress with our discussion.



Slide 5

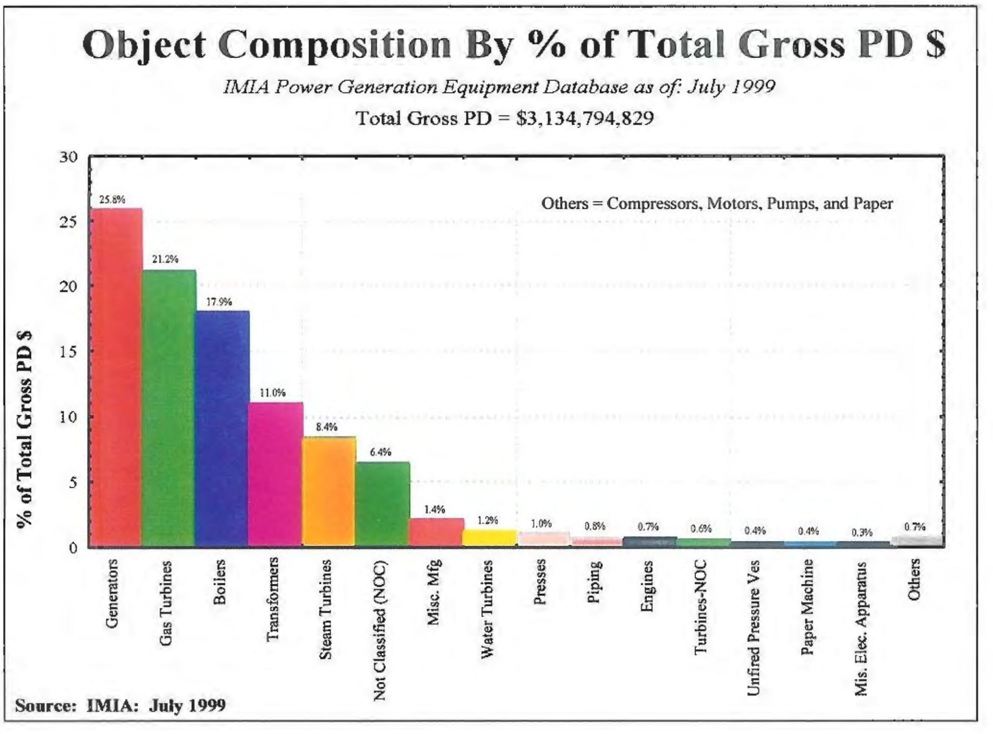
Let me refresh your memories for those of you who have seen this presentation in the past and for those who are new to IMIA, let me identify that the database we have does not necessarily represent a true analysis or picture of how objects age and their failure rates. There are certain filters that we have to realize that are in front of the data before the data gets into the database.

That is the individual carriers, and their risk selection criteria as to which risks they choose to underwrite or not underwrite, will affect what is put into the database. Particular insurance terms and conditions as to where coverage may be applied vs. other lines of insurance (most notable is electrical injury) differs by country. And lastly, there is the issue of deductibles. In some markets, very low deductibles are written with correspondingly high premiums, and in other markets, very high deductibles are written. Typically in the U.S. market, as an example, very high deductibles are written on Power Generation equipment, so the information represented there will not have a lot of what we would call "small losses" which would show up in other country databases because they write lower deductibles. So at the end, we have a filtered view of objects as they age and fail. Nonetheless, if we understand these filters and their impact on the data, we can still garner a lot of useful information from the database.



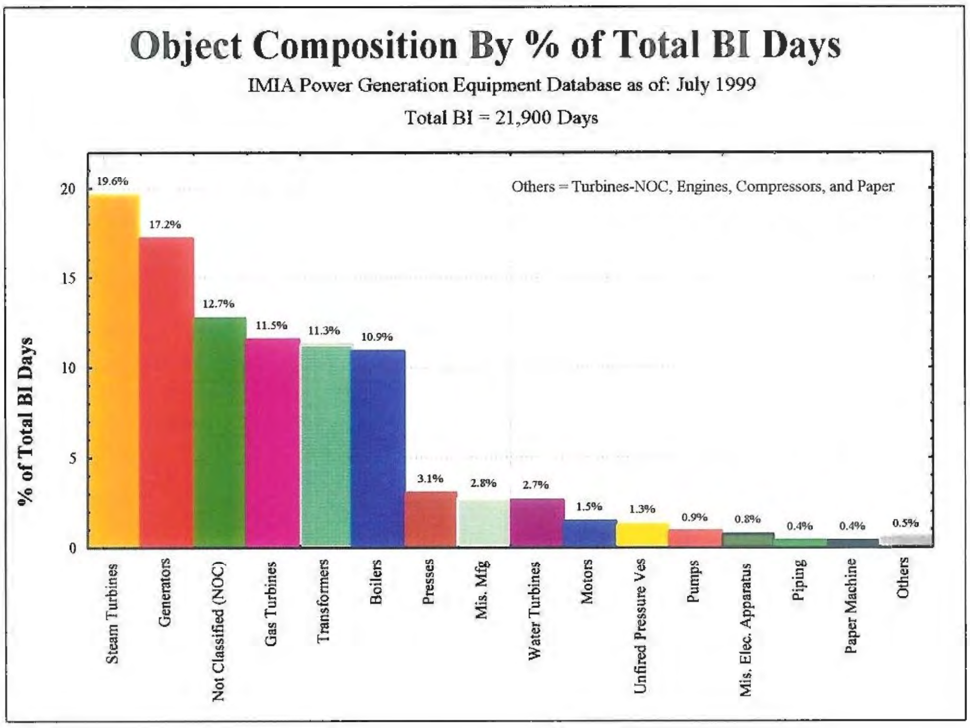
Slide 6

This is a breakdown of the most recent data call of the number of total records by type of object. We have had to do some grouping, and you can see that boilers are the most prevalent, representing 18.6% of the new data call; generators were next prevalent at 12.6% of the records; gas turbines at 11%; transformers at 10%, etc. You can see we have quite a broad spread of objects, and I'll just point out that MEA stands for Miscellaneous Electrical Apparatus, which is basically electric distribution switchgear.



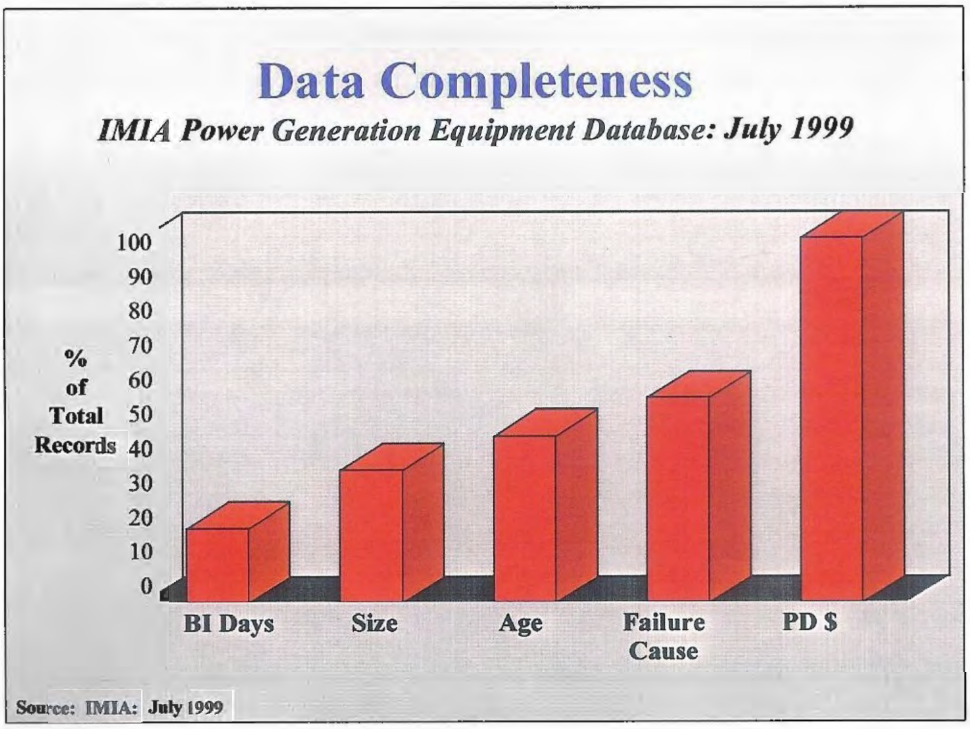
Slide 7

This is a comparison of the dollars of total loss (Property Damage only), represented by those same object groups we saw in the last slide. You can see that generators, gas turbines, boilers and transformers are still the most prevalent; but generators now are 25.8% of the total dollars of physical damage losses this time vs. representing only 12.6% of the numbers of failures. Gas turbines were 21.2% of the dollars and only 11.1% of the failures. Boilers, as you recall, were the most prevalent at 18.6% of the records, but they represent only 17.9% of the dollars. Lastly, transformers representing 10.4% of the number of records and 11% of the total dollars. Steam turbines were roughly comparable 8.4% of the dollars and 7.2% of the failures.



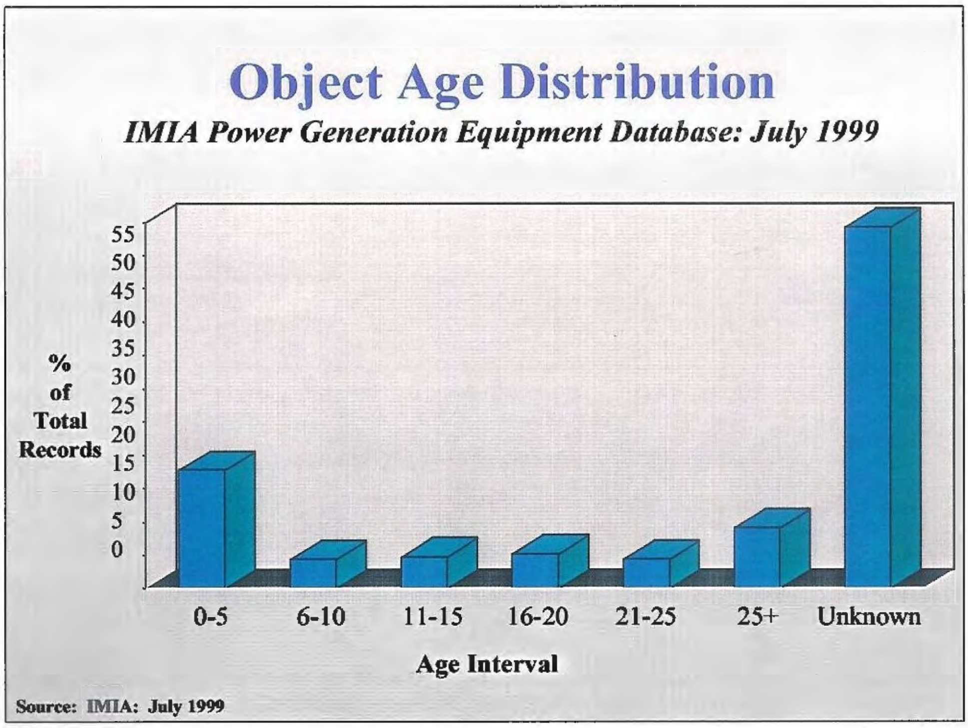
Slide 8

This is a breakdown of the number of BI days for those records for which we received that information. Remember, out of the total number of records we received (about 2100) only about 400 had this information, so the information is going to be a bit incomplete. But this is not unusual. In some markets, like in the U.S., Business Interruption is not purchased in some industries like public utilities so the number of BI outage days is not normally included in the records submitted. Having said that, steam turbines still represent most of the BI outage days at 19.6% with generators next at 17.2%. Since the U.S. represents about one-half of the records received in the most recent data call, these are truly outstanding figures.



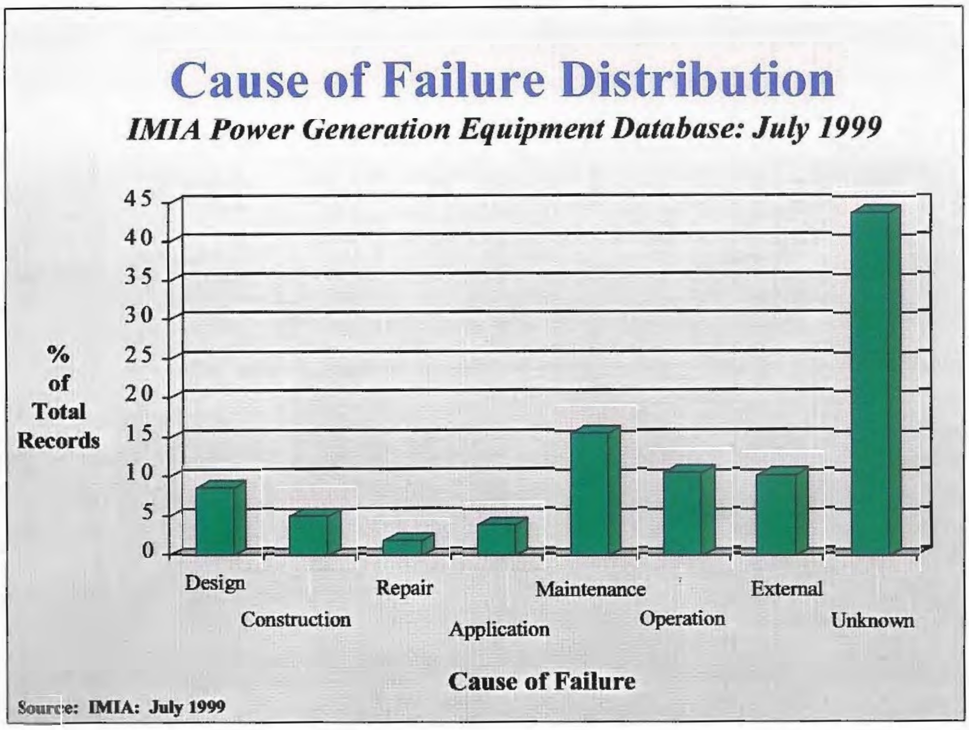
Slide 9

We have been talking about data completeness. This next chart is really showing that roughly 99% of the files we received had some amount of physical damage in dollars shown. On the other hand, roughly only 55% of those same records showed a failure cause; roughly 45% showed the age of the piece of equipment, which is really very unfortunate, because for half of the records we received we do not know how old they are. Also, roughly 35-37% of the records had object size indicated, but only 20% had BI days. So you can see that as we get finer and finer in our breakdown and analysis, we start losing data completeness. We'll be talking about how we can try to improve these percentages in the future as we progress.



Slide 10

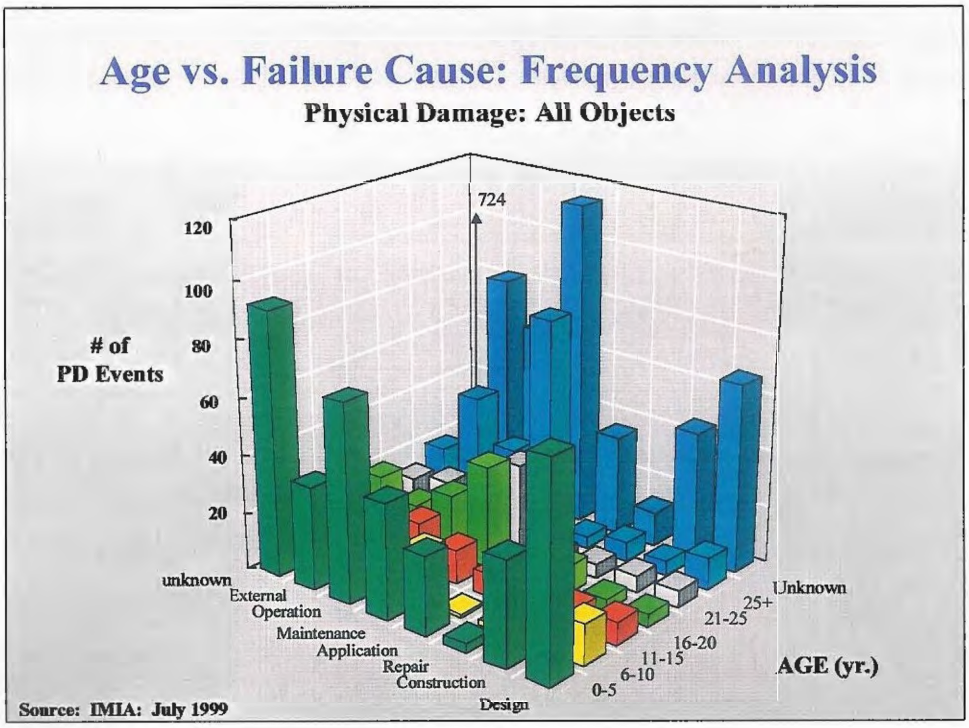
The next chart is object age distribution. Here is the distribution of ages of equipment in the records that we received with this most recent data call. As you can see, it roughly follows a bathtub curve. However, in over 50% of the objects in the information we received this time, no age was shown, which is a tremendous amount of lost information that we will try to work on improving in the future.



Slide 11 - Cause of Failure Distribution

This chart shows a breakdown between design, construction, repair, application, maintenance, operation and external. Remember what I said earlier, some differences in coverage between various country markets do exist, so we had to do some intelligent grouping. But I do want to point out again, that of the files we received, almost 45% of them did not have a cause of failure at all. So roughly half of the records we have from this most recent data call don't have meaningful information.

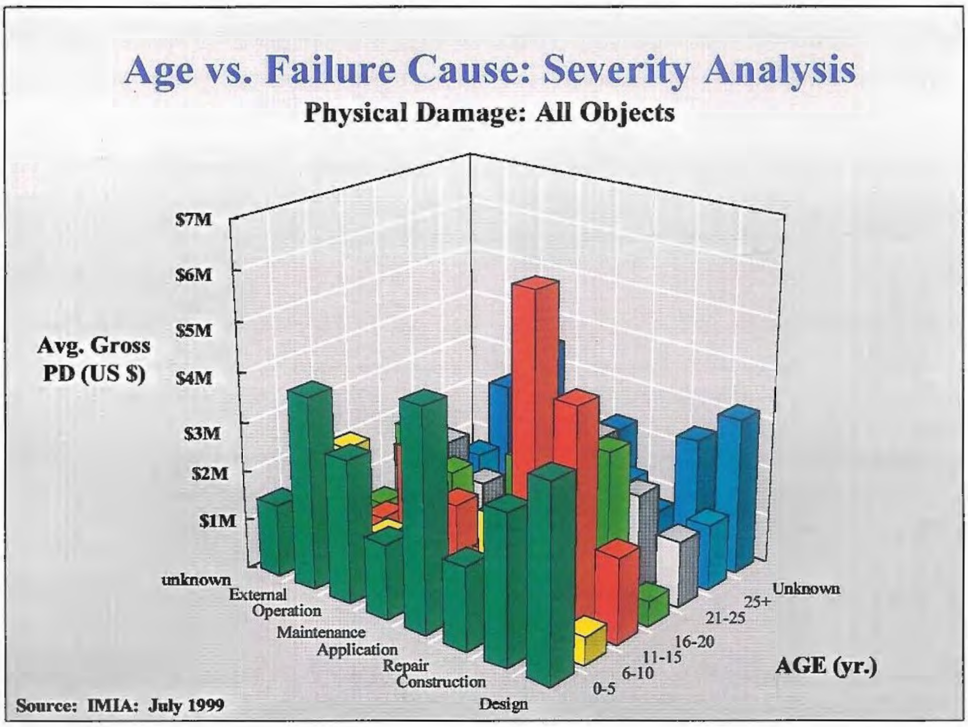
The other interesting point I would like to make at this time: If we were to combine the maintenance and operation and perhaps repair categories, and call that "human element," that would represent the largest single category, as opposed to issues of design or construction or external. If we threw in construction as part of human element, it would be even more astounding as a percent of the total. This seems to be consistent with the comments Mr.. Schittek made earlier in the conference.



Slide 12 Age vs. Failure Cause: Frequency Analysis

This next chart, "Age vs. Failure Cause by Frequency Analysis," is a difficult chart to look at. Let me try to explain it to you for those of you who can't recall or who have never seen this type of chart. It's a three-dimensional bar chart showing the number of physical damage events in the upper axis cross-referenced against the age of the piece of equipment regardless of what type it was, by the failure cause. So let me take an example for you. If you look in the center front, the age of a piece of equipment of 0-5 years and the design row, you will see a tall green column, roughly at 40 events. So that's how it's read. If you look at where we have a lot of events in the 0-5 year category, trailing off again, a little bit more in the back end at 25+, but again, looking at the number unknown for age, we see a tremendous amount of data there. And when we look again on the right-hand axis, or failure cause, we see that design seems to have a big impact at 0-5 years, much less so farther on. On the other hand, if we were to look at operation at the 25-year +, we see much more information. Again, if we were to combine maintenance and operation into one category and call it "human element," depending on whether or not we want to add repair or construction, we see that that would be tremendously large as a factor, particularly if we were to add in the files that are unknown as to age but known as to cause of failure

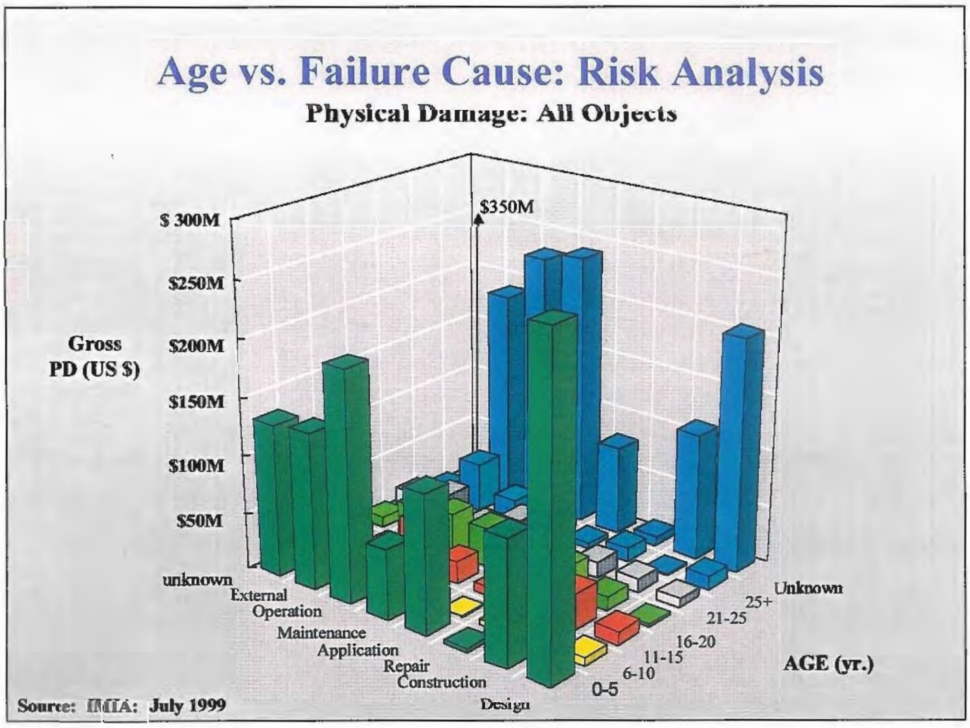
.Lastly, I just want to caution, look at the back row on the right, which is the "Unknown" row under "Failure Cause"; these are the files where we don't know the failure cause, and for some of them we also don't know the age. So again a lot of missing data, but we're starting to see some trends that are very important and very interesting, which we hope to study further.



Slide 13 Age vs. Failure Cause: Severity Analysis

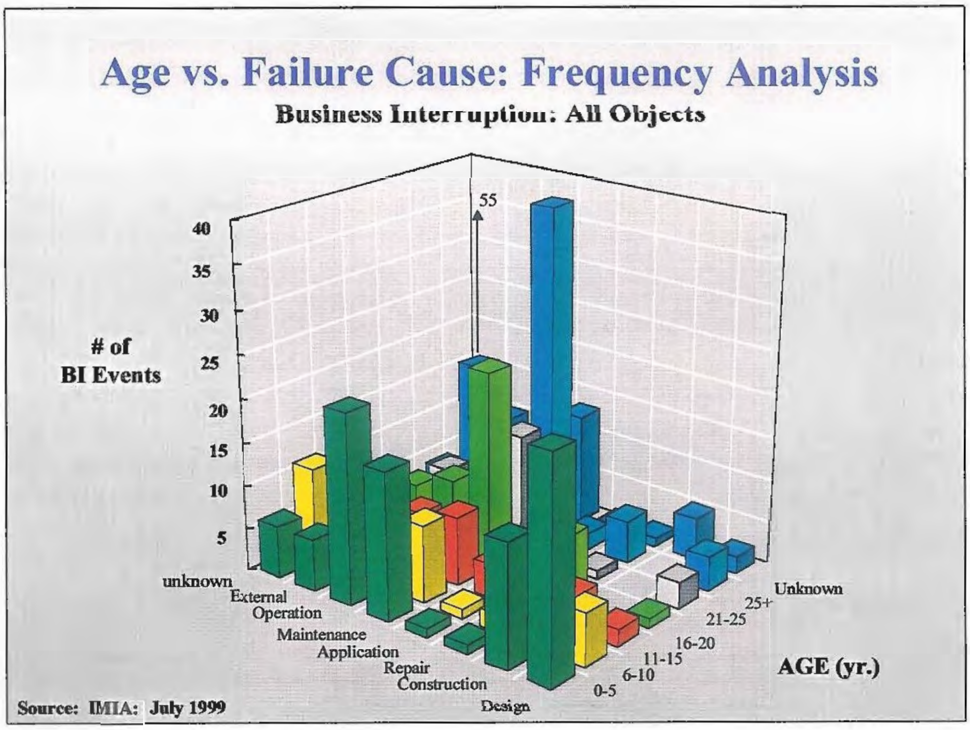
Next chart is "Age vs. Failure Cause for Severity Analysis." It tries to show the same type of analysis, but this time the vertical axis is the average gross physical damage loss. That's showing the total amount of physical damage dollars paid for each category. For example, take age 0-5 for design, that first green bar center front that looks to me to be about $3 million. If we look at the columns and rows, we see here, because we have most of the information that has physical damage dollars, again we show the same amount of unknown losses for age and unknown for cause of failure, but the dollars now, are a little more filled out, and particularly in the column, we notice a difference in the age column of 11-15 years (those blue bars), and particularly for construction and repair. Now again, if we add together operation, maintenance and repair as one element, that would be a very tall single bar.

Also what's interesting is if you look at the age group of 25+, it's very hard to see those gray bars because the dollars seem to be lower in proportion to younger failures, again, 0-5 years being a tremendously high-on-average cost, regardless of the reason.



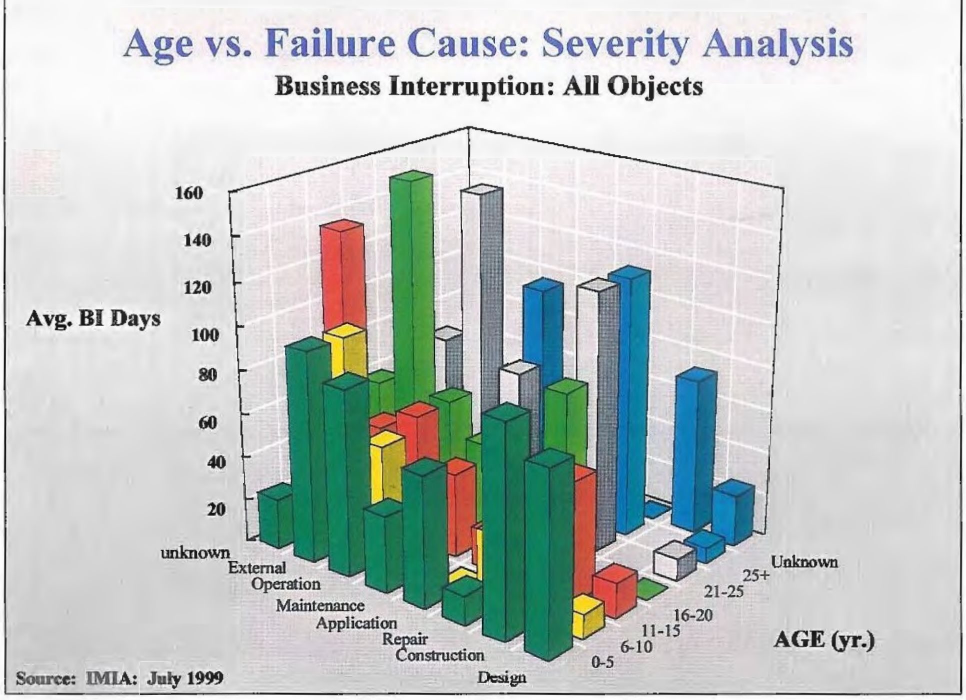
Slide 14 - Age vs. Failure Cause: Risk Analysis

This is again showing gross physical damage dollars. We can see that the "Unknown" category really dwarfs the amount of information with the exception of objects in the 0-5 year category. This may purely be a function of data capture, in that it may be of more interest in more countries to look at these claims and capture data when the object is very young as opposed to a normal distribution. If we can fill in age on more records, this would be, I think, a much more meaningful chart.



Slide 15 - Age vs. Failure Cause: Frequency Analysis

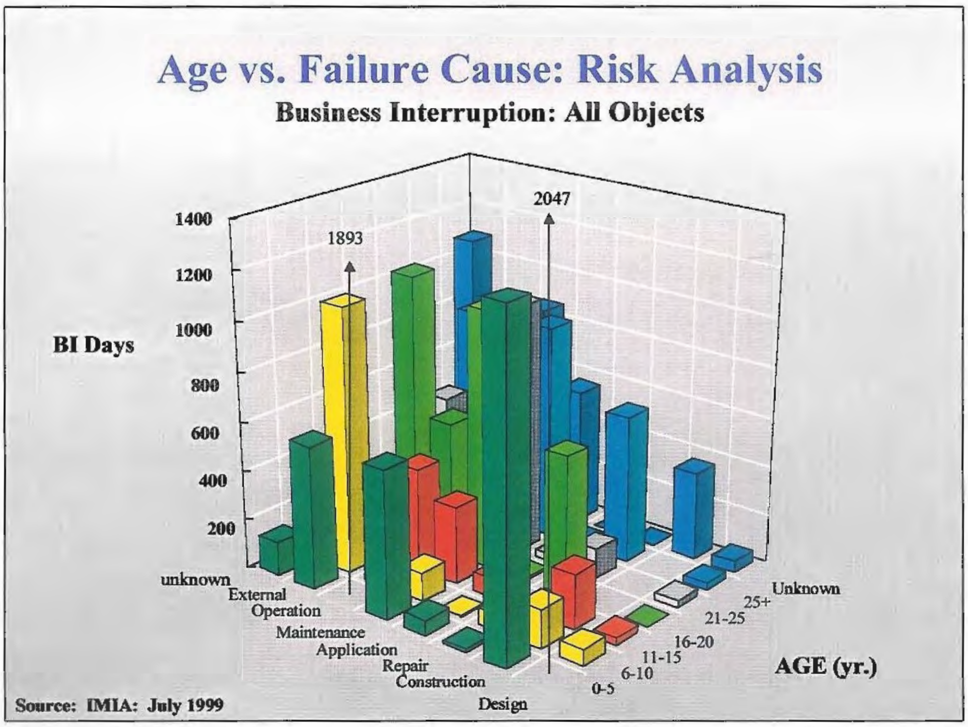
This is looking at number of Business Interruption events in this same group. We can see that the Unknown amounts are relatively small, but the percent of files representing Business Interruption is a relatively small (26% or so) percentage of the total. The data here is a little bit thin, but it's beginning to show something. First of all, we see again, 0-5 years for design and construction is a significant issue. Also we see that maintenance and operation, for all the age groups, is a very significant operation, particularly so for the 25 years and older objects. If we were to combine maintenance and operation, it would be a huge percentage of this total population. Very interesting information is starting to come out of the data.



Slide 16 - Age vs. Failure Cause: Severity Analysis

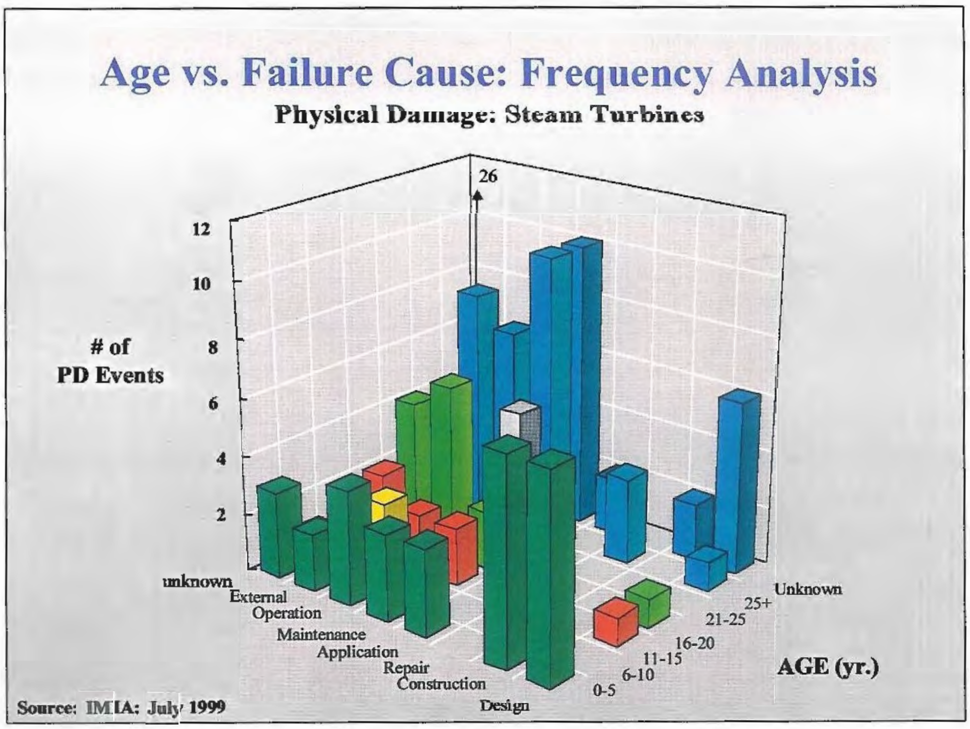
Here we are starting to get some very interesting data as we look across all object types for Business Interruption severity. We can see that the design and construction categories for young objects are very interesting, but not significant issues once the object gets to be 5 years old or older. If we look at maintenance and operation, again they are very significant over all the age groups. Repair, as a category, becomes very interesting once the object hits 16 years of age. Also, the amount of the external category is very high here; these could be lightning, power surges, etc., and again, this will vary market to market. This may be dominated by the U.S. market statistics, which include lightning and power surges in Machinery Breakdown Insurance.

Lastly, the unknown failure cause is relatively insignificant with the exception of one object group, which is 11-15. We'll have to look at how we can analyze that. We do see in the Unknown age row, which is the back row, some interesting spikes that may have an impact on the data once we clean it up.



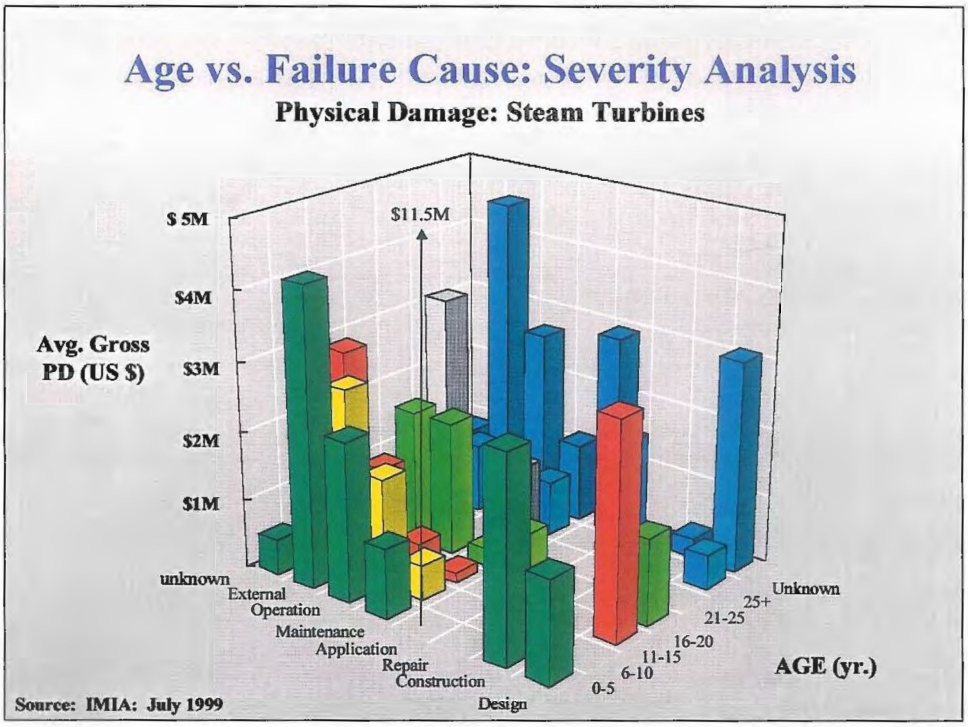
Slide 17 - Age vs. Failure Cause: Risk Analysis

This is looking at total Business Interruption days for all object types in the most recent data update, again, by age and failure cause, regardless of the piece of equipment. You can see that just due to the lack of total data, only 400 records this time, the data is a bit thinly-populated on our graph. If we added to previous-year graphs, we would have, I think, much more interesting data, but we do see some things popping out: the construction category for young objects shows very long Business Interruption outage times; we also see that objects 16-20 and 20-25 years have very long repair times. Break down outage time by maintenance and operation are again significant issues. Unusually, we see the external categories being quite substantial. So some very interesting data exists here which I think will lead us to some interesting conclusions in the future.



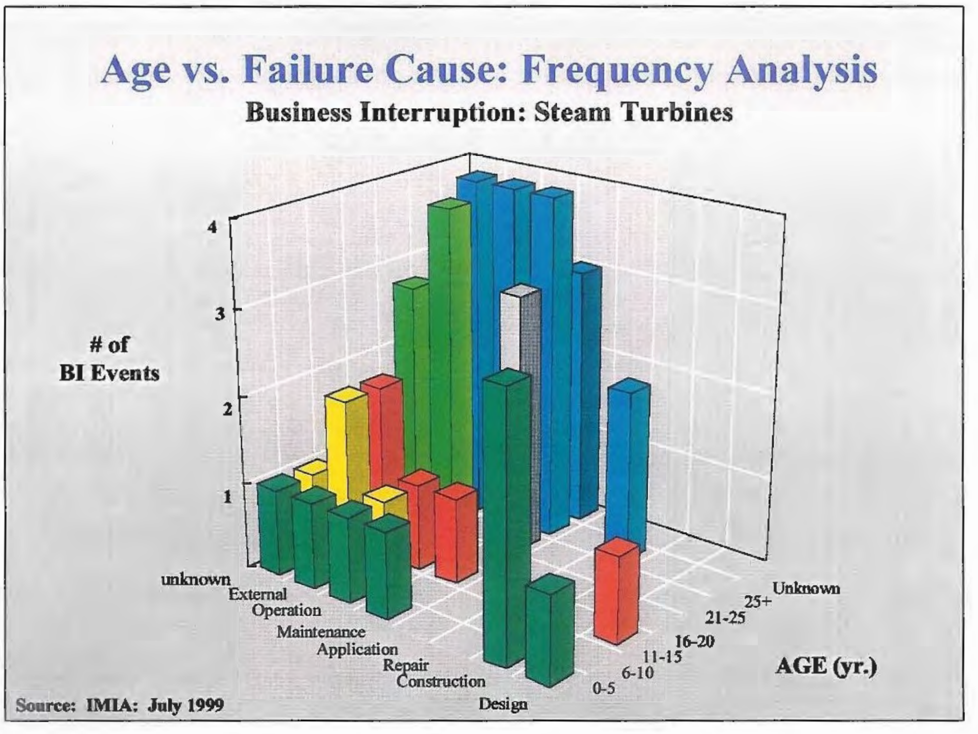
Slide 18 - Age vs. Failure Cause: Frequency Analysis for Steam Turbines

This chart identifies one object group, steam turbines, for physical damage events vs. age and cause of failure. Remembering that in an earlier chart, steam turbines represent 7.2% of the records submitted in the most recent data call and that number represents approximately 8.4% of the gross Physical Damage dollars and 19.6% of the gross Business Interruption outage days. Here we are talking about number of Physical Damage events. You can see that the chart is a bit thinly populated, but there are some interesting items. One is that in the over 25 year category, there is a large number of failures due to operation and external, as well as unknown. Also in the 0-5 year category, there is the best population for all categories with the exception of repair. Some interesting data here. What is also interesting to note, is that in the unknown age group, there is an equal amount of failures to the over 25 group for operation.



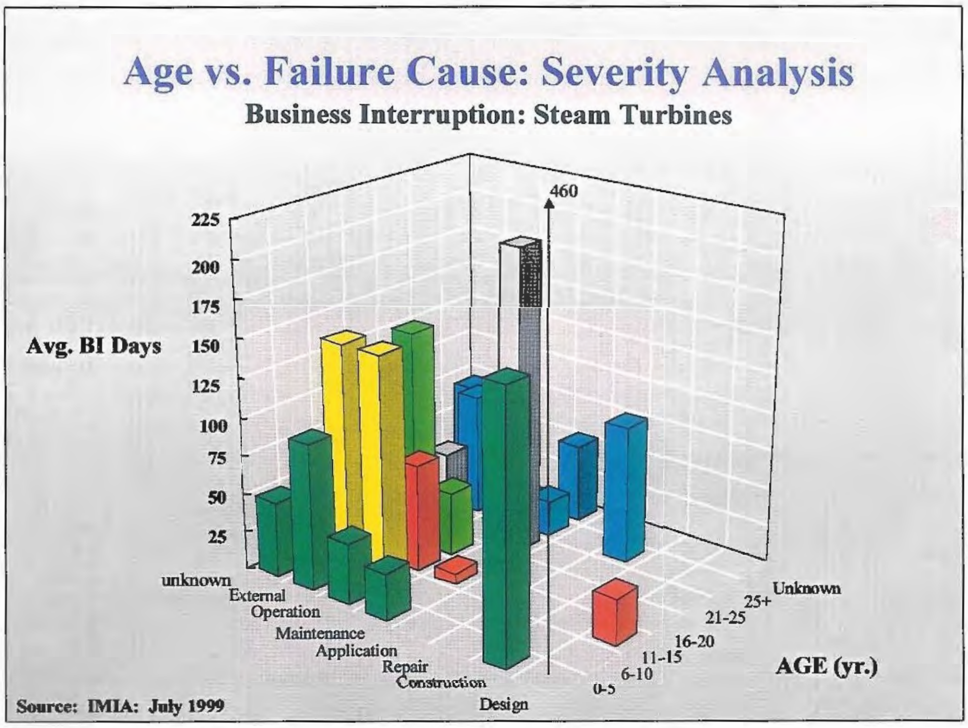
Slide 19 - Age vs. Failure Cause: Severity Analysis for Steam Turbines

This is on the severity side for physical damage and represents the average gross dollars. Here we see a bit more evenly spaced data with a bit of the same thing for young objects 0-5 years old with design and construction as in the last chart. Maintenance and Operation also come into play. In the age group 21-25 years, there is quite a spike in the Unknown Failure category from the look of it and in the Unknown Age Group. Again, if we were to add maintenance and operation, and called it human element, it would dominate the chart.



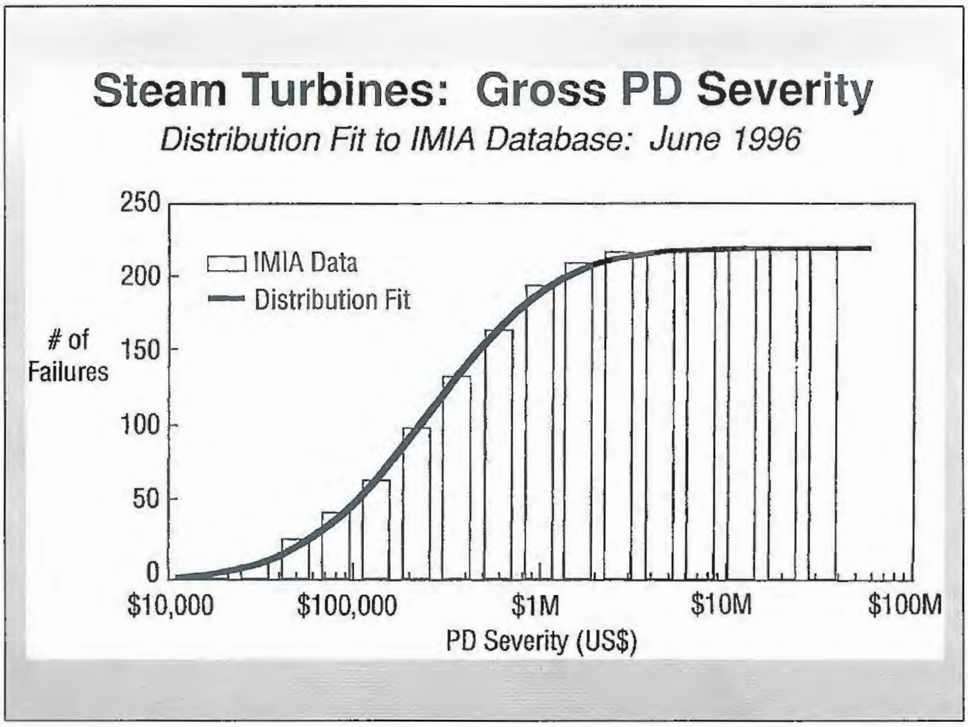
Slide 20 - Age vs. Failure Cause: Frequency Analysis for Steam Turbines

This chart shows a number of business interruption outages for steam turbines by failure cause. Now we can see some clustering. In the over 25 age group, there is quite a bit of clustering for Operation and External (as well as Unknown, unfortunately). Also, we see clustering across all age groups for Maintenance, Operation and External. If we added Maintenance and Operation together, it would dominate the chart. Other types of failure causes may not be as representative because of the way the data is collected from the various companies and countries that submitted information. It may be, that for this group of objects for Business Interruption, data is not collected, or it's not collected with the same categories.



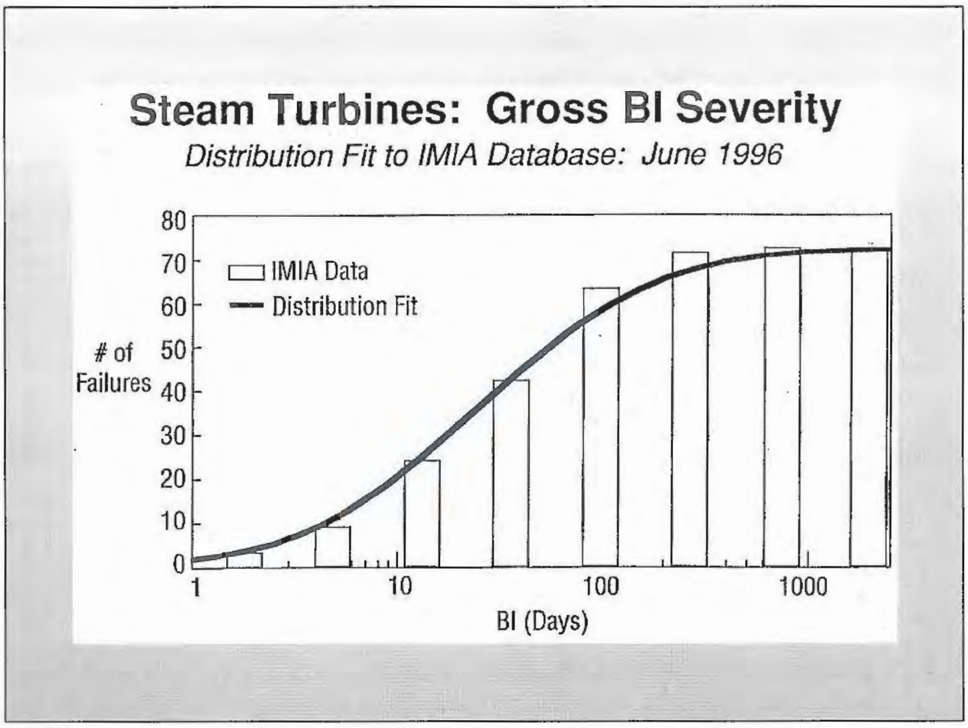
Slide 21 – Age vs. Failure Cause: Severity Analysis for Steam Turbines

This chart shows the average business interruption outages for steam turbines by cause of failure. Again, we can see the clustering for Operation and External. We can also see a bit of a spike with 0-5 years under Construction, and from 21-25 years under Maintenance. Here, again, it may be a factor of how the data is collected, and for those limited numbers of steam turbines that have business interruption coverage. Keep in mind that much of the U.S. database, in terms of public utilities, does not buy Business Interruption and so the number of BI days or BI events we show could be effected.



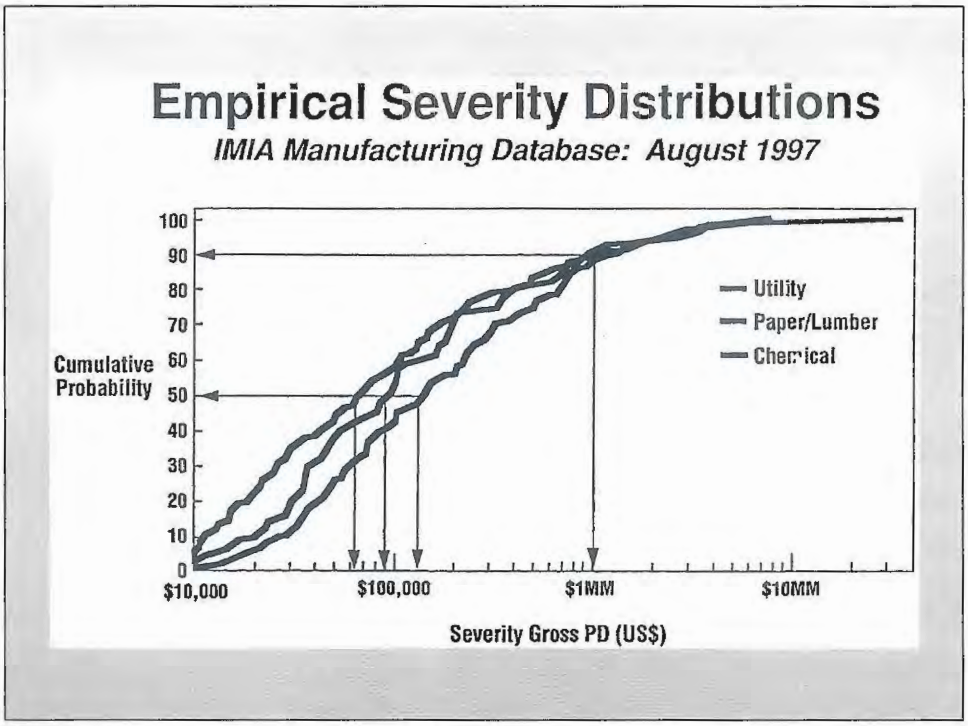
Slide 22 – Steam Turbines: Gross PD Severity - June 1996

Now, if we look at the next chart, this is the curve of Gross Physical Damage Severity on steam turbines from the update we did in June of 1996. As you can see, the data at that time in terms of number of failures very closely approximated a standard statistical curve. Over the past two data calls, this data curve still fits very closely. This is due to the law of central tendencies.



Slide 23 Steam Turbines: Gross BI Severity – June 1996

The gross Business Interruption severity, which is in the next chart, is similar and shows not quite as good a fit to another standard statistical curve. Because of the sparseness of the additional data, we see that this fit is not significantly different from what we had in 1996. Still, all in all, very good.



Slide 24: Empirical Severity Distributions

Lastly, again a chart that we used in 1997 with the three different industries: Utility, Pulp/Paper/Lumber, and Chemical. Just look at the Utility line, which is the one farthest to the right. What it says is, the cumulative probability of a loss is that 50% of the losses will be in excess of $100,000 in the Utility area and there's a 90% chance that one in ten will be over $1,000,000. These curves are still reasonably good and reasonably accurate, and we will be fitting more data to these curves in the future.

Again, I'd like to thank all of the submitting countries and companies and all of their delegations for the amount of hard work represented. We will, as a study group, be analyzing the entire database in further detail for report at the next IMIA Conference in September 2000 in Munich, and we are requesting help from other delegations to assist in analyzing the data. In addition, we will be putting out a data cleanup call to see if we can add some information to the claims we already have where we do not have data for all the fields.

Thank you very much. I'd like to express my thanks to Dr. Richard Jones and to Elizabeth Liu from Hartford Steam Boiler who did all the data analysis for this report.