



**QUESTIONNAIRE REPORT ON
HYDROGENERATORS FIRE PROTECTION UPDATE
STUDY OF THE GROUP 3- INSURERS' ANSWERS
(March 2010)**

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PLEASE READ THIS FIRST:

This version of this paper was prepared for a CARE - *Computer Aided Reading* by means of “hyperlinks” that allow a fast and easy navigation throughout the pages either from the text part or the corresponding annexes.

We encourage you to take advantage of this possibility. The “hyperlinks” are marked by bold underlined text areas (**to activate the hyperlink on WORD version** hold the Control “CTRL” key down then press the left mouse button – pointing at the desired link – **on PDF version** – less precise – just click on the link):

a)- On the Index part the number of the question is the “hyperlink” that leads to the corresponding question.

b)- On the end of each question you find the following “Hyperlink”

[Back to Index] [Go to Annex]

That leads either back to the Index or to the corresponding annex.

c)- On the Annex Part you find at the end of each table the “hyperlink”:

[Back to Question]

That makes easy to come back to the corresponding question.

As you can see all efforts were made to ensure an easy and quick reading of this document. Now it's your turn...

F - This is the fourth step of this task that got answers of 5 Insurance Companies that contributed with their valuable participation concerning the **Group 3 – Insurance Companies, Reinsurance Companies or Insurer Brokers**.

It was not easy to get these contributions and they are being considered in spite of being only five companies that agreed upon to answer to our questionnaire. We have to point out that none of them is a CIGRÉ member; therefore they did not have any obligation to help this work whatsoever. Their completely volunteer contributions are very important to understand the point of view of one major player in the decision chain that leads to the use of GFP to protect Hydro Generators. Herewith we express our gratitude for this participation.

We include herewith for the sake of better understanding all answers related to this group. We will follow the item numbering of the first part as well as the item numbers of the original Questionnaire (with the numbering correction made in some items) with the prefix “F”. The index of this part of the GFP UPDATE is as follows:

F 3 - Questionnaire with focus on Insurance Companies, Reinsurance Companies or Insurance Brokers:

[F 3.1](#) - Is fire protection for hydro generators required from a plant owner to insure a power plant?

[F 3.1.1](#) - Does the requirement of fire protection depend upon the size of the units or any other factors?

[F 3.1.1.1](#) - Do you require any kind of special supervisory technical equipment to be installed on the machines you cover the risk as for instance stator and runner temperature supervision/monitoring?

[F 3.1.2](#) - Do you follow any standards or you have your own rules to deal with hydro generators?

[F 3.1.2.1](#) - What are the factors that imply in a reduction of hydro generators fire risks?

[F 3.2](#) - Does your company have preference for or recommends any one of the existing generator fire extinguishing methods?

[F 3.3](#) - Is there a policy of insurance cost reduction depending upon the type of fire protection?

[F 3.3.1](#) - Is there any requirement from your side concerning maintenance of the fire fighting equipment and power plant's personnel fire training?

[F 3.3.1.1](#) - If you answered the last item (3.3.1) with yes do you verify if you customer is attending to the requirements of maintaining the equipment properly and keeping the personnel trained?

[F 3.4](#) - Did you have any claim of refund of damages caused by isolated hydrogenerators fire in the last 30 years?

[F 3.4.1](#) - If yes, please give the basic available data (Plant, Country, Quantity of affected generators, year of the fire, etc).

[F 3.4.2](#) - If yes, can you specify if the damaged plant had generator fire protection installed?

[F 3.4.2.1](#) - If yes, did fire protection work properly during the accident?

[F 3.4.3](#) - If yes, is it possible to inform the alleged cause of the fire?

[F 3.4.4](#) - Was there any consequential damage to other units or to other equipment installed outside the generator housing?

[F 3.4.5](#) - Was the refund paid?

[F 3.5](#) - According to your opinion, is there any question that is missing in this part of the questionnaire?

Now passing to the detailed discussion of each item, not forgetting that the pertinent tables with the statistical records of all items are shown in the annex, we have:

F 3.1 -

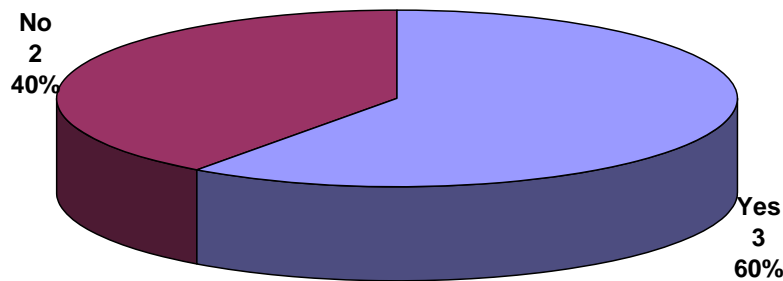
3.1) Is fire protection for hydro generators required from a plant owner to insure a power plant?

- Yes - No

If yes, please state some details here:

This is a combined question, check-box with complement open question. The check-box part showed the following:

3.1 - Is fire protection for hydro generators required from a plant owner to insure a power plant?



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Open question analysis results (If yes, please state some details here): Although the number of answers is little we made graphics to speed up the reading of the results, that in this way can be seen in a glance.

Grouping	Legend	Quantity
Grouping A	GFP recommended or required	2
Grouping B	At least detection	1
Grouping C	Blank	2
Total of answered questions		5

The explanations given constitute the richer part of the contributions given by the Insurance companies, so we present them as follows:

For the Grouping A (GFP recommended or required):

-The American Insurer coded EMP018, explained that: *“Fire protection is generally recommended for hydrogenerators. Gaseous extinguishing systems and water spray systems are the recommended solutions.”*

- The Chinese Insurer coded EMP021, explained that: *“The fire protection insurance required from the customer is based on the requirement of our National fire security regulation and specifications.”*

For the Grouping B (At least detection):

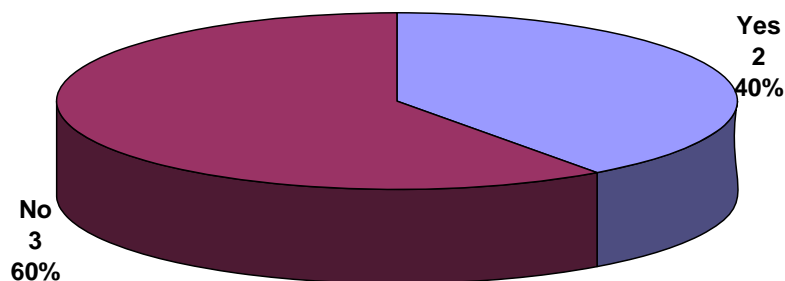
- The German Insurer coded EMP022, explained that: *“at least fire detection relayed directly to the fire brigade”* are required.

F 3.1.1 -

3.1.1) Does the requirement of fire protection depend upon the size of the units or any other factors?
 - Yes - No
If Yes, which are the factors you use to apply?

The check-box part of this question (Yes/No) showed the following result:

3.1.1 - Does the requirement of fire protection depend upon the size of the units or any other factors?



Open question analysis results (If Yes, which are the factors you use to apply?), for this explanatory question we got two answers:

-The American Insurer coded EMP018, explained that: *“The replacement value of the unit as well as its criticality (i.e. the monetary value associated with not being able to generate electricity) is considered.”*

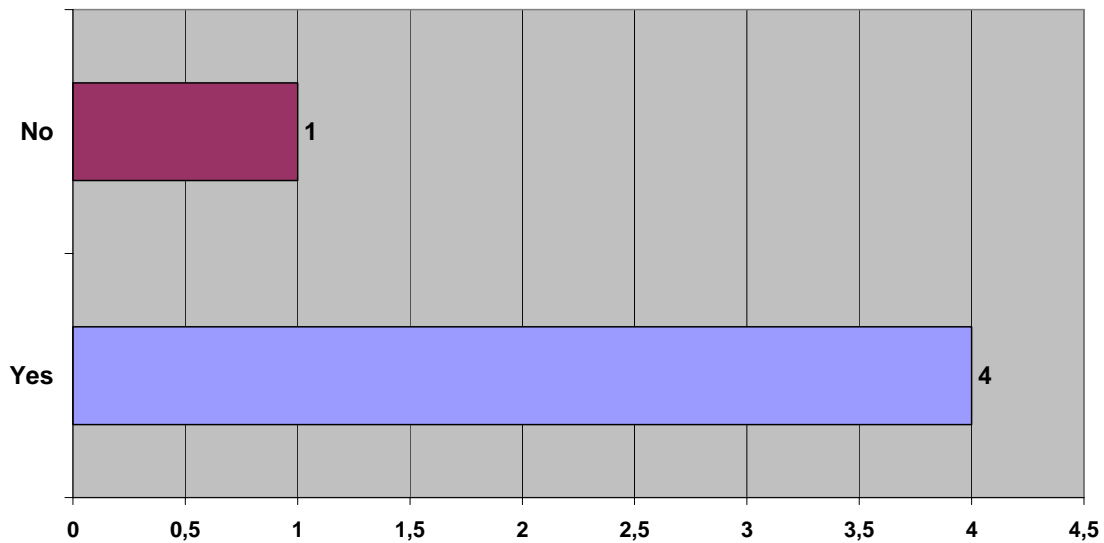
- The German Insurer coded EMP022, explained that: *“Power and number of units in 1 fire area.”* This is a risk assessment parameter.

F 3.1.1.1 -

3.1.1.1) Do you require any kind of special supervisory technical equipment to be installed on the machines you cover the risk as for instance stator and runner temperature supervision/monitoring?
 - Yes - No
If Yes, which are they, please comment?

The check-box part of this question showed the following situation:

3.1.1.1 - Do you require any kind of special supervisory technical equipment to be installed on the machines you cover the risk as for instance stator and runner temperature supervision/monitoring?



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Open question analysis results (If Yes, which are they, please comment), this additional question complements the question above and resulted in the following additional information:

- The American Insurer coded EMP018, explained that: *“In addition to the IEEE recommended generator electrical protection, we also recommend thermal detectors under the top cover of the hydrogenerator and/or embedded in the windings as well as photoelectric smoke detectors or a very early warning fire detection system to active the fire protection system. We also recommend that a “lock-out” relay be installed to prevent the generator being re-energized without a proper investigation as to why the electrical protection operated.”*
- The Chinese Insurer coded EMP021, explained that he requires: *“Smoke and heat detector.”*
- The German Insurer coded EMP022, requires: *“Full state of the art condition monitoring.”*
- The Swedish Insurer coded EMP052, explained that: *“Temperature monitoring for windings in rotor and stator, as well as vibration monitoring.”*

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F 3.1.2 -

3.1.2) Do you follow any standards or you have your own rules to deal with hydro generators?

- Yes - No

If yes, please state some details here:

The check-box part of this question had the following result:

EMP018 (United States)	Yes
EMP021 (China)	Yes
EMP022 (Germany)	Yes
EMP024 (Norway)	No
EMP052 (Sweden)	Yes

The question was stated to find out how many insurance companies do follow own Standards; the exploratory question throws more light to it.

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Open question analysis results (If yes, please state some details here), as the answers will show the involved Insurers did not focus on the difference between using own Standards or existing ones:

- The American Insurer coded EMP018, explained that: *“We follow IEEE standards, NFPA standards as well as our own FM Global standards.”*
- The Chinese Insurer coded EMP021, explained that: *“The standards we strictly follow are made by National (Chinese) fire extinguishing commission.”*
- The German Insurer coded EMP022, informed that uses: *“own standards developed with power companies.”* This is a step forward since there is the Users participation in the establishment of the Insurer’s operating rules.
- The Swedish Insurer coded EMP052, explained that he uses: *“Standards and partly own guidelines.”*

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F 3.1.2.1 -

3.1.2.1) What are the factors that imply in a reduction of hydro generators fire risks?

This is a pure open question and the information passed by the Insurers is very important and interesting; it may serve as guideline for cost-minded users:

- The American Insurer coded EMP018, explained that: *“Replacement value, criticality, combustible loading, electrical protection, fire protection, and operating conditions. Other factors such as the age of the machine and whether the station is normally attended also play a part.”*
- The Chinese Insurer coded EMP021, explained that: *“The factors are, for example, quantity of main parts manufacturing and erection, inspecting and maintenance operation and commissioning of unit as well as the high attention to foreseen fire risk and personnel fire training.”*
- The German Insurer coded EMP022, informed that the important points are: *“Condition monitoring, fire protection (turbine oil systems; generator; cable routes), fire load through oils, fire separation.”*
- The Norwegian Insurer coded EMP024, explained that he requires: *“Automatic fire detection systems and fire extinguishing systems.”*
- The Swedish Insurer coded EMP052, explained that : *“Loss prevention: service and maintenance. Operation risk: automatic extinguishing systems.”*

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F 3.2 -

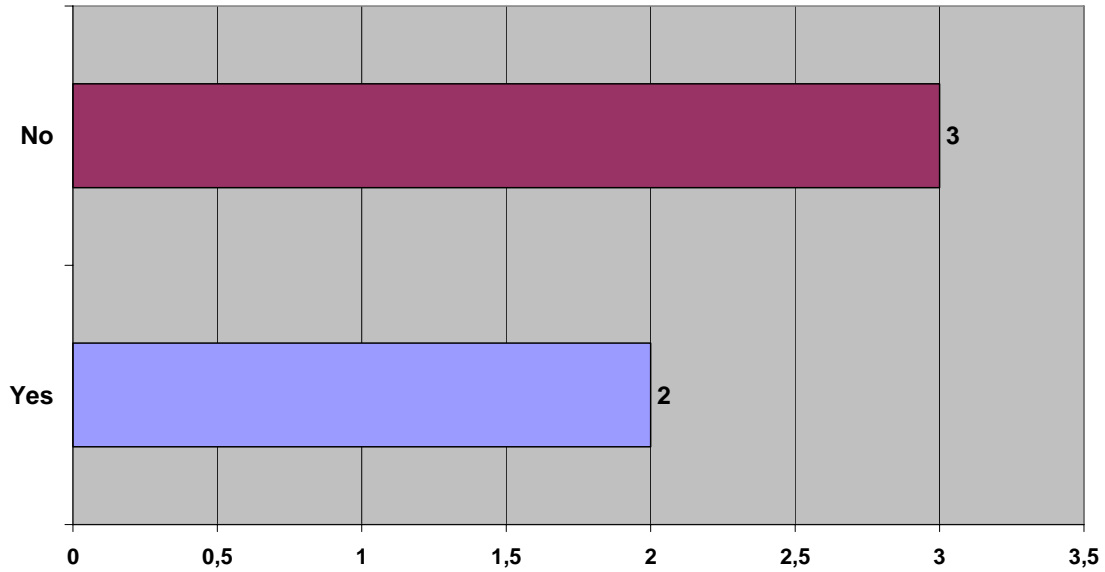
3.2) Does your company have preference for or recommends any one of the existing generator fire extinguishing methods?

- Yes - No

If yes, please specify here:

The check-box part of this question has the following result:

3.2 - Does your company have preference for or recommends any one of the existing generator fire extinguishing methods?



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Open question analysis results (If yes, please specify here), the two Insurers that answered yes stated their answer as follows:

- The American Insurer coded EMP018, explained that: *“We recommend either water spray or gaseous fire suppression systems.”*
- The German Insurer coded EMP022, recommends: *“Inert gas (e.g. CO2) and sprinkler.”*

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F 3.3 -

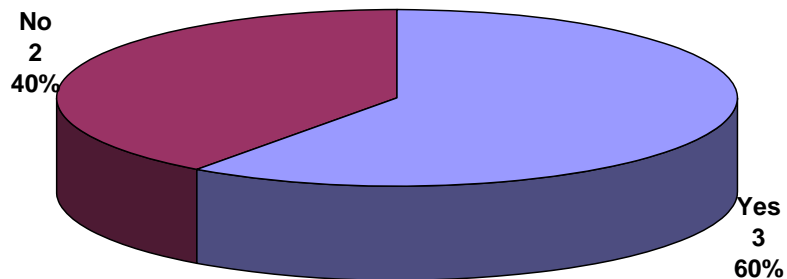
3.3) Is there a policy of insurance cost reduction depending upon the type of fire protection scheme the user installs?

- Yes - No

If yes, please specify here:

This composed question shows the following result for the check-box part:

3.3 - Is there a policy of insurance cost reduction depending upon the type of fire protection scheme the user installs?



This result shows that the practice of cost reduction in case of use of certain type of GFP is common among the insurance companies. In our universe the majority does it.

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Open question analysis results (If yes, please specify here); since we had three answers “Yes” here are the corresponding additional explanations:

-The American Insurer coded EMP018, explained that: *“This is company confidential information which we cannot share in detail. However in general terms, FM Global underwrites based on the quality of risk. Fire protection is one aspect of determining risk quality.”*

- The German Insurer coded EMP022, referred to a former item, as follows: “see 3.1.2.1.: *Condition monitoring, fire protection (turbine oil systems; generator; cable routes), fire load through oils, fire separation.*”

- The Swedish Insurer coded EMP052, explained that this grants a: *“Fire premium reduction”*

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F 3.3.1 -

3.3.1) Is there any requirement from your side concerning maintenance of the fire fighting equipment and power plant’s personnel fire training?

- Yes - No

If yes , please specify here:

This is an important issue considering that in many cases the maintenance of the GFP equipment is neglected this not allowing it to work properly when necessary.

The check box part of this question showed the following result: all five Insurers answered “Yes”.

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Open question analysis results (If yes, please specify here); the details were given by the participant Insurance Companies, as follows:

- The American Insurer coded EMP018, explained that: *“FM Global has requirements for routine inspection and testing of fire protection systems. We also have requirements for training of power station personnel in emergency response.”*
- The Chinese Insurer coded EMP021, explained that: *“Normally, after the completion of generator installation e together with the fire fighting organization and the customer have a detailed inspection for the measures and the equipment, protection system and other related facilities.”*
- The German Insurer coded EMP022, informed that the important points are: *“Based on international standards (CEA, VdS, NFPA,....).”*
- The Norwegian Insurer coded EMP024, explained that he requires: *“Yearly: Maintenance / control of fire extinguishing equipment + fire training if more than 40 employees.”*
- The Swedish Insurer coded EMP052, explained that: *“According to Swedish Standards.”*

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F 3.3.1.1 -

3.3.1.1) If you answered the last item (3.3.1) with yes do you verify if you customer is attending to the requirements of maintaining the equipment properly and keeping the personnel trained?
 - Yes - No
 If yes , please specify here:

The check-box part of the question showed that all participant Insurers do verify the compliance with maintenance and personnel training, with exception of the Chinese Insurer that answered “No”.

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Open question analysis results (If yes, please specify here), in accordance with the check-box answers we got four comments, as follows:

- The American Insurer coded EMP018, explained that: *“FM Global engineers visit power stations on a routine basis to verify that fire protection equipment is being tested and maintained. And if the personnel is regularly trained.”*
- The German Insurer coded EMP022, explained that: *“We check documentation of tests and trainings.”* This is an “believe-type” verification, because it relies on paper work confirmation, instead of field checking.
- The Norwegian Insurer coded EMP024, explained that: *“Verified during our inspections.”*
- The Swedish Insurer coded EMP052, explained that: *“Certificates and Questionnaires.”*

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F 3.4 -

3.4) Did you have any claim of refund of damages caused by isolated hydrogenerators fire in the last 30 years?
 - Yes - No

This pure check-box question (Yes/No) starts a sequence of questions that got important answers based upon real accident situation reported. The result achieved is the following:

Company	Result
	Answer

EMP018 (United States)	Yes
EMP021 (China)	No
EMP022 (Germany)	Yes
EMP024 (Norway)	Blank
EMP052 (Sweden)	No

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F 3.4.1 -

3.4.1) If yes, please give the basic available data (Plant, Country, Quantity of affected generators, year of the fire, etc). Should several examples be available please feel free to give the data in a table.

A table was made in order to allow the information of several accidents, thus enlarging the experience gathering of this survey. The following questions, up to the question F 3.4.5 , do consider the multiple information received. The question F 3.4.1 is a pure open question and the answers received are as follows, and show the Insurers perspective regarding this type of accidents:

-The American Insurer coded EMP018 used the table and presented five complete examples that are identified by Gen 01 to Gen 05:

Gen 01	<p>130 MVA unit</p> <p>Electrical protection cleared a stator fault.</p> <p>Fire protection did not activate because the temperature in the generator housing did not reach a sufficiently high level.</p> <p>The unit was returned to service in about a week.</p>
Gen 02	<p>2 x 130 MVA units.</p> <p>In two separate and unrelated incidents, stator insulation failure ignited the insulation of two different generators.</p> <p>Fire protection operated and controlled the fire. The fire protection was activated by temperature detectors in the generator housing.</p> <p>The units were repaired and returned to service in 3 months.</p>
Gen 03	<p>280 MVA unit</p> <p>Electrical protection operated due to stator insulation failure and cleared the fault.</p> <p>Fire protection operated because stator winding temperature was high. The heat was generated by the electrical fault. The insulation did not catch on fire.</p> <p>Approximately 10 sq m of stator was damaged.</p> <p>The unit was returned to service after 6 months</p>
Gen 04	<p>170 MVA unit</p> <p>Unit was in a planned outage.</p> <p>Smoke from welding operating activated water spray protection</p>

	<p>Unit was not dried.</p> <p>After the outage the unit was placed in service several days later and it suffered a stator insulation breakdown.</p> <p>The generator had to be dried and 36 stator coils were removed for repairs.</p> <p>The unit was returned to service after 3 months.</p>
Gen 05	<p>130 MVA unit</p> <p>Fire occurred in stator end turn insulation.</p> <p>Smoke activated water spray system and controlled fire.</p> <p>Damaged coils were repaired.</p> <p>Unit was air dried for 24 hours and returned to service in 3 days</p>

- The German Insurer coded EMP022 reported accident with two units, the first two are related to the same unit in different conditions:

Gen 01(a)	In 1995 there was no protection on the generator, resulting in a €10 Mio loss
Gen 01(b)	After the loss in this unit a CO2-protection was installed with manual release - the second loss in 2000 resulted in a €1,5Mio loss as the CO2-protection was released with a delay of 200 minutes - today the system has automatic release - up to now no further loss, but estimates are below €0,2Mio.
Gen 02	In the 1990s there was a total loss of a 60 MW generator in a cavern in Sweden - no further details are known

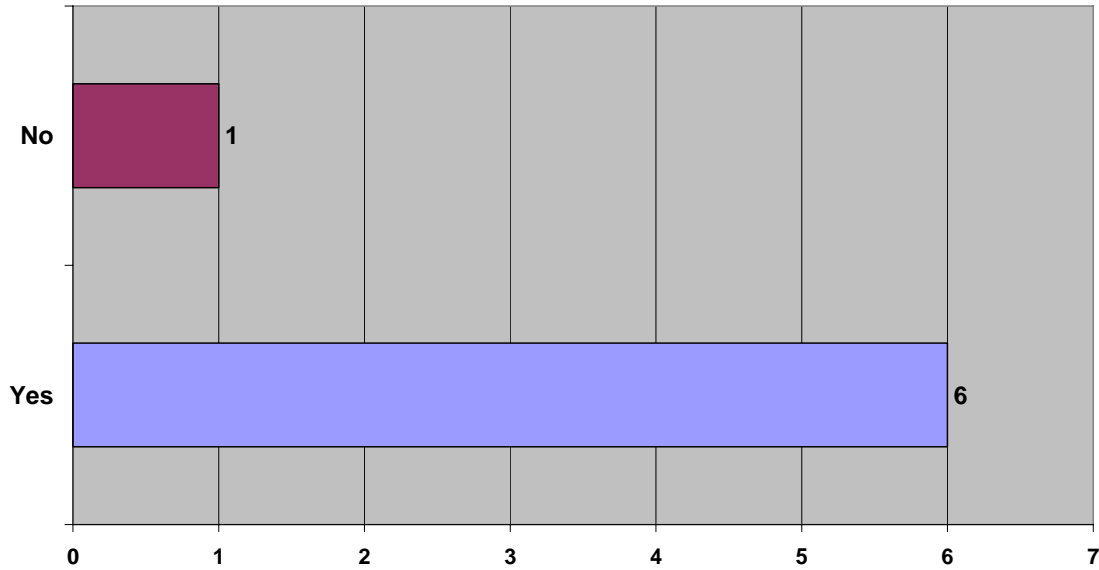
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F 3.4.2 -

<p>3.4.2) If yes, can you specify if the damaged plant had generator fire protection installed?</p> <p><input type="checkbox"/> - Yes <input type="checkbox"/> - No</p>

For this pure check-box question the following result was achieved:

3.4.2 - If yes, can you specify if the damaged plant had generator fire protection installed?



The “No” answer is related to the accident reported under Gen 01(a) by the German Insurer that in the first stage had no GFP installed. But after the installation of the GFP the decision was taken to rely on manual release; and when a second accident occurred the long time of 200 minutes (>than 3 hours!) to trigger the GFP release still caused a major damage to the unit. Now the release was changed to automatic.

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F 3.4.2.1 -

3.4.2.1) If yes, did fire protection work properly during the accident?

- Yes - No

Any additional comment and or information?

The check box part of this combined question result is displayed below. Due to the structure of the answers the indication with the evaluation table may give a better understanding:

Insurance Company	Gen Units	Result
		Answer
EMP018 (United States)	Gen 01	Yes
	Gen 02	Yes
	Gen 03	Yes
	Gen 04	Yes
	Gen 05	Yes
EMP021 (China)		Blank
EMP022 (Germany)	Gen 01(a)	Blank
	Gen 01(b)	No
	Gen 02	Blank
EMP024 (Norway)		Blank
EMP052 (Sweden)		Blank

Again the blank on the Gen 01(a) reported by the German Insurer stands for the fact that initially the unit had no GFP installed.

Open question analysis results (Any additional comment and or information?) the answers are reach in details and for the sake of better understanding the compilation table is shown below:

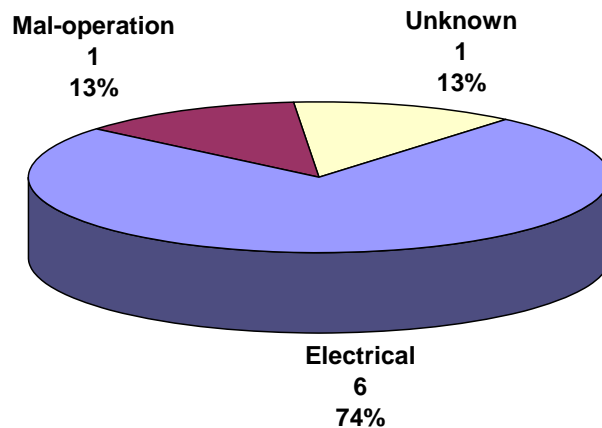
Insurance Company	Gen Units	Result
		Answer
EMP018 (United States)	Gen 01	Although fire protection did not operate, it was not designed to operate if electrical protection is able to clear the fault and prevent a fire from developing.
	Gen 02	Blank
	Gen 03	Even though there was no actual fire, the fire protection system was considered to have operated properly because it was designed to operate when the stator winding temperature exceeded a certain level.
	Gen 04	Fire protection worked as designed but this was a mal-operation because the fire protection was operated by smoke generated by welding and not an actual fire.
	Gen 05	Today the system has automatic release - up to now no further loss, but estimates are below €0,2Mio.
EMP021 (China)		Blank
EMP022 (Germany)	Gen 01(a)	2 losses 1995 and 2000 in the same unit in Germany - therefore the mention to Gen 1(a) and Gen 1(b) to indicate that the comments do refer to the same machine in two different times.
	Gen 01(b)	Blank
	Gen 02	Blank

F 3.4.3 -

<p>3.4.3) If yes, is it possible to inform the alleged cause of the fire?</p> <p><input type="checkbox"/> - electrical</p> <p><input type="checkbox"/> - mechanical</p> <p><input type="checkbox"/> - influence from outside the generator housing</p> <p><input type="checkbox"/> - other...</p> <p>Any additional comment and or information?</p>

The check-box part offered the following alternatives: electrical, mechanical, influence from outside the generator housing and other... And we got the following result:

3.4.3 - If yes, is it possible to inform the alleged cause of the fire?



The “mal-operation” alternative is related to the smoke-sensor that reacted to the smoke of a soldering machine; in this case it is to check if the GFP is to be kept sharp during maintenance works or if other solution has to be taken under these circumstances. The “unknown” alternative (left blank in the questionnaire) is related to the accident that occurred in the nineteenth reported by the German Insurer – for which no detail was available any more.

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Open question analysis results (Any additional comment and or information?) this part of the question did not receive any comment.

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F 3.4.4 -

3.4.4) Was there any consequential damage to other units or to other equipment installed outside the generator housing?

- Yes - No

Any additional comment and or information?

The answers received for his check-box part (Yes/No) were given only by the American Insurer that informed that in none of the five accidents he reported a consequential damage occurred. The other did not mark any check box whir resulted in blank answers.

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Open question analysis results (Any additional comment and or information?) this part of the question did not receive any comment.

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F 3.4.5 -

3.4.5) Was the refund paid?

- Yes - No

If not, what were reasons that impeached the payment after your due diligence on the

fire itself?

Closing this very interesting section of questions and answers, in which the American Insurer made a significant contribution to this work, we have the following answers to the check-box part (Yes/No):

The refund was paid for all five accidents reported by the American Insurer and the three informed by the German Insurer.

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Open question analysis results (If not, what were reasons that impeached the payment after your due diligence on the fire itself?) this part of the question did not receive any comment, because all refunds were paid.

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F 3.5 -

3.5) According to your opinion, is there any question that is missing in this part of the questionnaire?

- Yes - No

If yes, please state it here:

For the check-box part (Yes/No) or this control question we got the following situation:

Company	Result
	Answer
EMP018 (United States)	No
EMP021 (China)	No
EMP022 (Germany)	No
EMP024 (Norway)	Blank
EMP052 (Sweden)	Yes

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Open question analysis results (If yes, please state it here); we got one interesting contribution that can be taken as a goal for any further development of this work:

The Swedish Insurer EMP052 suggested the following items for a further discussion:

“Risk estimation factors like maintenance/overhaul,

Intermittent operation (faster aging, wear and tear),

Education (operation personnel) and

Outsourcing (service/maintenance)”

These are interesting aspects concerning the Insurers perspective.

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Annexes F - The original complete statistical tables that support the item F of this Work

F 3.1 Check-Box

Question	Company	Result
		Answer
3.1) Is fire protection for hydro generators required from a	EMP018 (United States)	Yes

plant owner to insure a power plant?	EMP021 (China)	Yes
	EMP022 (Germany)	Yes
	EMP024 (Norway)	No
	EMP052 (Sweden)	No

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F 3.1 Open question

3.1) Is fire protection for hydro generators required from a plant owner to insure a power plant?			
Question	Company	Result	Grouping
		Answer	
If yes, please state some details here:	EMP018 (United States)	Fire protection is generally recommended for hydrogenerators. Gaseous extinguishing systems and water spray systems are the recommended solutions.	A
	EMP021 (China)	The fire protection insurance required from the customer is based on the requirement of our National fire security regulation and specifications.	A
	EMP022 (Germany)	At least fire detection relayed directly to the fire brigade.	B
	EMP024 (Norway)	Blank	C
	EMP052 (Sweden)	Blank	C
Summary			
Grouping	Legend		Quantity
Grouping A	GFP recommended or required		2
Grouping B	At least detection		1
Grouping C	Blank		2
Total of answered questions			5

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F 3.1.1 Check-Box

Question	Company	Result
		Answer
3.1.1) Does the requirement of fire protection depend upon the size of the units or any other factors?	EMP018 (United States)	Yes
	EMP021 (China)	No
	EMP022 (Germany)	Yes
	EMP024 (Norway)	No
	EMP052 (Sweden)	No

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F 3.1.1 Open question

3.1.1) Does the requirement of fire protection depend upon the size of the units or any other factors?		
Question	Company	Result
		Answer
If Yes, which are the factors you use to apply?	EMP018 (United States)	The replacement value of the unit as well as its criticality (i.e. the monetary value associated with not being able to generate electricity) is considered.
	EMP021 (China)	Blank
	EMP022 (Germany)	Power and number of units in 1 fire area.
	EMP024 (Norway)	Blank

	EMP052 (Sweden)	Blank
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F 3.1.1.1 Check-Box

Question	Company	Result
		Answer
3.1.1.1) Do you require any kind of special supervisory technical equipment to be installed on the machines you cover the risk as for instance stator and runner temperature supervision/monitoring?	EMP018 (United States)	Yes
	EMP021 (China)	Yes
	EMP022 (Germany)	Yes
	EMP024 (Norway)	No
	EMP052 (Sweden)	Yes

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F 3.1.1.1 Open question

3.1.1.1) Do you require any kind of special supervisory technical equipment to be installed on the machines you cover the risk as for instance stator and runner temperature supervision/monitoring?		
Question	Company	Result
		Answer
If Yes, which are they, please comment?	EMP018 (United States)	In addition to the IEEE recommended generator electrical protection, we also recommend thermal detectors under the top cover of the hydrogenerator and/or embedded in the windings as well as photoelectric smoke detectors or a very early warning fire detection system to active the fire protection system. We also recommend that a "lock-out" relay be installed to prevent the generator being re-energized without a proper investigation as to why the electrical protection operated.
	EMP021 (China)	Smoke and heat detector.
	EMP022 (Germany)	Full state of the art condition monitoring.
	EMP024 (Norway)	Blank
	EMP052 (Sweden)	Temperature monitoring for windings in rotor and stator, as well as vibration monitoring.

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F 3.1.2 Check-Box

Question	Company	Result
		Answer
3.1.2) Do you follow any standards or you have your own rules to deal with hydro generators?	EMP018 (United States)	Yes
	EMP021 (China)	Yes
	EMP022 (Germany)	Yes
	EMP024 (Norway)	No
	EMP052 (Sweden)	Yes

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F 3.1.2 Open question

3.1.2) Do you follow any standards or you have your own rules to deal with hydro generators?			
Question	Company	Result	Grouping
		Answer	
If yes, please state some details here:	EMP018 (United States)	We follow IEEE standards, NFPA standards as well as our own FM Global standards.	A
	EMP021 (China)	The standards we strictly follow are made by National fire extinguishing commission.	B
	EMP022 (Germany)	own standards developed with power companies.	B
	EMP024 (Norway)	Blank	C
	EMP052 (Sweden)	Standards and partly own guidelines	B
Summary			
Grouping	Legend		Quantity
Grouping A	NFPA, IEEE and own Standards		1
Grouping B	Own Standars-guidelines		3
Grouping C	Blank		1
Total of answered questions			5

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F 3.1.2.1 Open question

3.1.2.1) What are the factors that imply in a reduction of hydro generators fire risks?

Question	Company	Result
		Answer
3.1.2.1) What are the factors that imply in a reduction of hydro generators fire risks?	EMP018 (United States)	Replacement value, criticality, combustible loading, electrical protection, fire protection, and operating conditions. Other factors such as the age of the machine and whether the station is normally attended also play a part.
	EMP021 (China)	The factors are,for example,quantity of main parts manufacturing and erection,inspecting and maintenance operation and commissioning of unit as well as the high attention to foreseen fire risk and personel fire training.
	EMP022 (Germany)	Condition monitoring, fire protection (turbine oil systems; generator; cable routes), fire load through oils, fire separation.
	EMP024 (Norway)	Automatic fire detection systems and fire extinguishing systems
	EMP052 (Sweden)	Loss prevention: service and maintenance. Operation risk: automatic extinguishing systems

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F 3.2 Check-Box

Question	Company	Result
		Answer
3.2) Does your company have preference for or recommends any one of the existing generator fire extinguishing methods?	EMP018 (United States)	Yes
	EMP021 (China)	No
	EMP022 (Germany)	Yes

	EMP024 (Norway)	No
	EMP052 (Sweden)	No

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F 3.2 Open question

3.2) Does your company have preference for or recommends any one of the existing generator fire extinguishing methods?		
Question	Company	Result
		Answer
If yes, please specify here:	EMP018 (United States)	We recommend either water spray or gaseous fire suppression systems.
	EMP021 (China)	Em Branco
	EMP022 (Germany)	Inert gas (e.g. CO2) and sprinkler.
	EMP024 (Norway)	Em Branco
	EMP052 (Sweden)	Em Branco

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F 3.3 Check-Box

Question	Company	Result
		Answer
3.3) Is there a policy of insurance cost reduction depending upon the type of fire protection scheme the user installs?	EMP018 (United States)	Yes
	EMP021 (China)	No
	EMP022 (Germany)	Yes
	EMP024 (Norway)	No
	EMP052 (Sweden)	Yes

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F 3.3 Open question

3.3) Is there a policy of insurance cost reduction depending upon the type of fire protection scheme the user installs?		
Question	Company	Result
		Answer
If yes, please specify here:	EMP018 (United States)	This is company confidential information which we cannot share in detail. However in general terms, FM Global underwrites based on the quality of risk. Fire protection is one aspect of determining risk quality.
	EMP021 (China)	Em Branco
	EMP022 (Germany)	see 3.1.2.1. : Condition monitoring, fire protection (turbine oil systems; generator; cable routes), fire load through oils, fire separation.
	EMP024 (Norway)	Em Branco
	EMP052 (Sweden)	Fire premium reduction

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F 3.3.1 Check-Box

Question	Company	Result
		Answer

3.3.1) Is there any requirement from your side concerning maintenance of the fire fighting equipment and power plant's personnel fire training?	EMP018 (United States)	Yes
	EMP021 (China)	Yes
	EMP022 (Germany)	Yes
	EMP024 (Norway)	Yes
	EMP052 (Sweden)	Yes

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F 3.3.1 Open question

3.3.1) Is there any requirement from your side concerning maintenance of the fire fighting equipment and power plant's personnel fire training?		
Question	Company	Result
		Answer
If yes , please specify here:	EMP018 (United States)	FM Global has requirements for routine inspection and testing of fire protection systems. We also have requirements for training of power station personnel in emergency response.
	EMP021 (China)	Normally, after the completion of generator installation e together with the fire fighting organization and the customer have a detailed inspection for the measures and the equipment, protection system and other related facilities.
	EMP022 (Germany)	Based on international standards (CEA, VdS, NFPA,....).
	EMP024 (Norway)	Yearly: Maintenance / control of fire extinguishing equipment + fire training if more than 40 employees.
	EMP052 (Sweden)	According to Swedish Standards

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F 3.3.1.1 Check-Box

Question	Company	Result
		Answer
3.3.1.1) If you answered the last item (3.3.1) with yes do you verify if you customer is attending to the requirements of maintaining the equipment properly and keeping the personnel trained?	EMP018 (United States)	Yes
	EMP021 (China)	No
	EMP022 (Germany)	Yes
	EMP024 (Norway)	Yes
	EMP052 (Sweden)	Yes

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F 3.3.1.1 Open question

3.3.1.1) If you answered the last item (3.3.1) with yes do you verify if you customer is attending to the requirements of maintaining the equipment properly and keeping the personnel trained?			
Question	Company	Result	Grouping
		Answer	
If yes , please specify here:	EMP018 (United States)	FM Global engineers visit power stations on a routine basis to verify that fire protection equipment is being tested and maintained. And that personnel is regularly trained.	A
	EMP021 (China)	Blank	C

	EMP022 (Germany)	We check documentation of tests and trainings.	B
	EMP024 (Norway)	Verified during our inspections	A
	EMP052 (Sweden)	Certificates and Questionnaires	C
Summary			
Grouping	Legend		Quantity
Grouping A	Visit the customers-inspections		2
Grouping B	Check documents -certificates		1
Grouping C	Blank		2
Total of answered questions			5

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F 3.4 Check-Box

Question	Company	Result
		Answer
3.4) Did you have any claim of refund of damages caused by isolated hydrogenerators fire in the last 30 years?	EMP018 (United States)	Yes
	EMP021 (China)	No
	EMP022 (Germany)	Yes
	EMP024 (Norway)	Blank
	EMP052 (Sweden)	No

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F 3.4.1 Open question

Question	Insurance Company	Gen Units	Result
			Answer
3.4.1) If yes, please give the basic available data (Plant, Country, Quantity of affected generators, year of the fire, etc).	EMP018 (United States)	Gen 01	130 MVA unit Electrical protection cleared a stator fault. Fire protection did not activate because the temperature in the generator housing did not reach a sufficiently high level. The unit was returned to service in about a week.
		Gen 02	2 x 130 MVA units. In two separate and unrelated incidents, stator insulation failure ignited the insulation of two different generators. Fire protection operated and controlled the fire. The fire protection was activated by temperature detectors in the generator housing. The units were repaired and returned to service in 3 months.

		Gen 03	<p>280 MVA unit Electrical protection operated due to stator insulation failure and cleared the fault. Fire protection operated because stator winding temperature was high. The heat was generated by the electrical fault. The insulation did not catch on fire. Approximately 10 sq m of stator was damaged. The unit was returned to service after 6 months</p>
		Gen 04	<p>170 MVA unit Unit was in a planned outage. Smoke from welding operating activated water spray protection Unit was not dried. After the outage the unit was placed in service several days later and it suffered a stator insulation breakdown. The generator had to be dried and 36 stator coils were removed for repairs. The unit was returned to service after 3 months.</p>
		Gen 05	<p>130 MVA unit Fire occurred in stator end turn insulation. Smoke activated water spray system and controlled fire. Damaged coils were repaired. Unit was air dried for 24 hours and returned to service in 3 days</p>
	EMP021 (China)		Blank
	EMP022 (Germany)	Gen 01(a)	In 1995 there was no protection on the generator, resulting in a €10 Mio loss
		Gen 01(b)	After the loss in this unit a CO2-protection was installed with manual release - the second loss in 2000 resulted in a €1,5Mio loss as the CO2-protection was released with a delay of 200 minutes - today the system has automatic release - up to now no further loss, but estimates are below €0,2Mio.
		Gen 02	In the 1990s there was a total loss of a 60 MW generator in a cavern in Sweden - no further details are known
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.4.2 Check-Box

Question	Insurance Company	Gen Units	Result
			Answer
3.4.2) If yes, can	EMP018	Gen 01	Yes

you specify if the damaged plant had generator fire protection installed?	(United States)	Gen 02	Yes
		Gen 03	Yes
		Gen 04	Yes
		Gen 05	Yes
	EMP021 (China)		Blank
	EMP022 (Germany)	Gen 01(a)	No
		Gen 01(b)	Yes
		Gen 02	
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.4.2.1 Check-Box

Question	Insurance Company	Gen Units	Result
			Answer
3.4.2.1) If yes, did fire protection work properly during the accident?	EMP018 (United States)	Gen 01	Yes
		Gen 02	Yes
		Gen 03	Yes
		Gen 04	Yes
		Gen 05	Yes
	EMP021 (China)		Blank
	EMP022 (Germany)	Gen 01(a)	Blank
		Gen 01(b)	No
		Gen 02	Blank
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.4.2.1 Open question

3.4.2.1) If yes, did fire protection work properly during the accident?			
Question	Insurance Company	Gen Units	Result
			Answer
Any additional comment and or information?	EMP018 (United States)	Gen 01	Although fire protection did not operate, it was not designed to operate if electrical protection is able to clear the fault and prevent a fire from developing.
		Gen 02	Blank
		Gen 03	Even though there was no actual fire, the fire protection system was considered to have operated properly because it was designed to operate when the stator winding temperature exceeded a certain level.

		Gen 04	Fire protection worked as designed but this was a mal-operation because the fire protection was operated by smoke generated by welding and not an actual fire.
		Gen 05	Today the system has automatic release - up to now no further loss, but estimates are below €2Mio.
	EMP021 (China)		Blank
	EMP022 (Germany)	Gen 01(a)	2 losses 1995 and 2000 in the same unit in Germany - therefore the mention to Gen 1(a) and Gen 1(b) to indicate that the comments do refer to the same machine in two different times.
		Gen 01(b)	Blank
		Gen 02	Blank
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.4.3 Check-Box

Question	Insurance Company	Gen Units	Result
			Answer
3.4.3) If yes, is it possible to inform the alleged cause of the fire?	EMP018 (United States)	Gen 01	Electrical
		Gen 02	Electrical
		Gen 03	Electrical
		Gen 04	Other - Mal-operation
		Gen 05	Electrical
	EMP021 (China)		Blank
	EMP022 (Germany)	Gen 01(a)	Electrical
		Gen 01(b)	Electrical
		Gen 02	Blank
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.4.3 Open question

3.4.3) If yes, is it possible to inform the alleged cause of the fire?			
Question	Insurance Company	Gen Units	Result
			Answer
Any additional comment and or information?	EMP018 (United States)	Gen 01	Blank
		Gen 02	Blank
		Gen 03	Blank
		Gen 04	Blank
		Gen 05	Blank
	EMP021 (China)		Blank
	EMP022	Gen 01(a)	Blank

	(Germany)	Gen 01(b)	Blank
		Gen 02	Blank
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.4.4 Check-Box

Question	Insurance Company	Gen Units	Result
			Answer
3.4.4) Was there any consequential damage to other units or to other equipment installed outside the generator housing?	EMP018 (United States)	Gen 01	No
		Gen 02	No
		Gen 03	No
		Gen 04	No
		Gen 05	No
	EMP021 (China)		Blank
	EMP022 (Germany)	Gen 01(a)	Blank
		Gen 01(b)	Blank
		Gen 02	Blank
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.4.4 Open question

3.4.4) Was there any consequential damage to other units or to other equipment installed outside the generator housing?			
Question	Insurance Company	Gen Units	Result
			Answer
Any additional comment and or information?	EMP018 (United States)	Gen 01	Blank
		Gen 02	Blank
		Gen 03	Blank
		Gen 04	Blank
		Gen 05	Blank
	EMP021 (China)		Blank
	EMP022 (Germany)	Gen 01(a)	Blank
		Gen 01(b)	Blank
		Gen 02	Blank
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.4.5 Check-Box

Question	Insurance Company	Gen Units	Result
			Answer

3.4.5) Was the refund paid?	EMP018 (United States)	Gen 01	Yes
		Gen 02	Yes
		Gen 03	Yes
		Gen 04	Yes
		Gen 05	Yes
	EMP021 (China)		Blank
	EMP022 (Germany)	Gen 01(a)	Yes
		Gen 01(b)	Yes
		Gen 02	Yes
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.4.5 Open question

3.4.5) Was the refund paid?			
Question	Insurance Company	Gen Units	Result
			Answer
If not, what were reasons that impeached the payment after your due diligence on the fire itself?	EMP018 (United States)	Gen 01	Blank
		Gen 02	Blank
		Gen 03	Blank
		Gen 04	Blank
		Gen 05	Blank
	EMP021 (China)		Blank
	EMP022 (Germany)	Gen 01(a)	Blank
		Gen 01(b)	Blank
		Gen 02	Blank
	EMP024 (Norway)		Blank
	EMP052 (Sweden)		Blank

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F 3.5 Check-Box

Question	Company	Result
		Answer
3.5) According to your opinion, is there any question that is missing in this part of the questionnaire?	EMP018 (United States)	No
	EMP021 (China)	No
	EMP022 (Germany)	No
	EMP024 (Norway)	Blank
	EMP052 (Sweden)	Yes

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F 3.5 Open question

3.5) According to your opinion, is there any question that is missing in this part of the questionnaire?		
Question	Company	Result
		Answer

If yes, please state it here:	EMP018 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP022 (Germany)	Em Branco
	EMP024 (Norway)	Em Branco
	EMP052 (Sweden)	Risk estimation factors like maintenance/overhaul, intermittent operation (faster aging, wear and tear), education (operation personnel), outsourcing (service/maintenance)

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