



**QUESTIONNAIRE REPORT ON
HYDROGENERATORS FIRE PROTECTION UPDATE
STUDY OF THE GROUP 2 - MANUFACTURERS' ANSWERS
(February 2010)**

Convener: Alexander Gromow (BR)

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...

E - This is the third step of this task that got answers of 10 manufacturers that contributed with their valuable participation concerning the **Group 2 - Manufacturers**. We include herewith for the sake of better understanding all answers related to this group, including those already shown in the first part of this task, as commented in the 2008 Paris Biannual Meeting. 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 "E". The index of this part of the GFP UPDATE is as follows:

E 2 - Questionnaire with focus on Generator Manufacturers:

[E 2.1](#) - From the generator manufacturer's standpoint, do you recommend the use of Generator Fire Protection?

[E 2.1.1](#) - If yes, which type?

[E 2.1.2](#) - If not, please state your reasons.

[E 2.2](#) - From your experience, which is the type of generator fire extinguishing method more frequently used nowadays?

[E 2.2.1](#) - Any change towards the former trend?

[E 2.3](#) - Which Standards do you apply in the design of the fire protection of your generators?

[E 2.3.1](#) - Are there critical items in the application of these Standards that require special attention?

[E 2.4](#) - What is the state of the art in the detection in accordance to your experience?

[E 2.4.1](#) - Which are the types of detection devices you normally use and/or recommend?

[E 2.4.2](#) - Do you recommend any specific detection and control system to minimize unwanted fire extinguishing system operation?

[E 2.5](#) - Does your company design generators suited to any of the existing fire extinguishing media (CO₂, Water Spray, Halon substitutes, etc.), or there are limitations from your side?

[E 2.5.1](#) - Should you have limitations, please state them here:

[E 2.6](#) - From the fire protection standpoint, the generator and its housing have to be considered as a whole in the design when fire extinguishing is to be installed, in order to guarantee the system's functionality and efficiency. Considering this fact are you always informed by the purchaser from the beginning of the generator's design of the future application of a specific generator fire protection method?

[E 2.6.1](#) - Are you requested to participate in the definition of the fire extinguishing system to be applied in one generator of your manufacture?

[E 2.6.2](#) - Did you have to adapt a ready generator design to a specific fire extinguishing system?

[E 2.7](#) - Modern insulation materials are mostly considered to be non-flammable, fire retardant or self-extinguishable. Since these aspects are subject to test conditions that sometimes diverge from actual accident situations, please check how the insulation material you use can be classified:

[E 2.7.1](#) - Do you test the flammability conditions of the materials you use by yourself?

[E 2.8](#) - Has any of the hydro generators you manufactured suffered a fire accident?

[E 2.8.1](#) - Was the origin of the fire determined?

[E 2.8.2](#) - Was the generator equipped with fire protection system?

[E 2.8.2.1](#) - Do you know if it did work properly?

[E 2.8.3](#) - Do you have any specific comment and/or information about the damages that occurred?

[E 2.8.4](#) - Would you like to state a general recommendation considering generator fire protection?

[E 2.9](#) - Besides the design and production of new generators, does your company participate in the refurbishment and/or maintenance area?

[E 2.9.1](#) -If yes, does it include the fire extinguishing systems?

[E 2.10](#) - According to your opinion, is there any question that is missing in this part of the questionnaire?

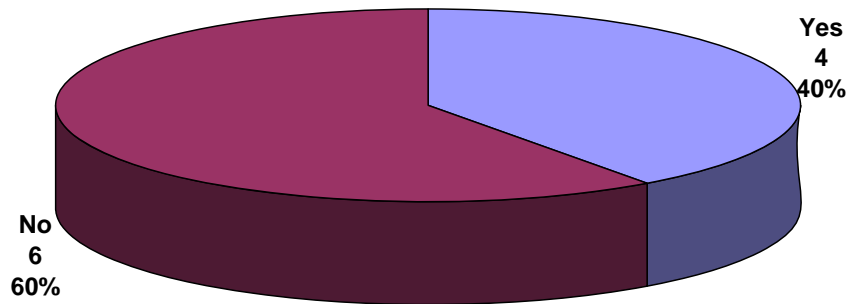
Now passing to the detailed discussion of each item, not forgetting that the pertinent tables with the statistical records of all items are shown in the corresponding annex, we have:

E 2.1 -

2.1) From the generator manufacturer's standpoint, do you recommend the use of Generator Fire Protection?
 - Yes - No

This is a basic question and shows the Manufacturer's tendency considering the use of GFP. This question was stated as a pure closed – check-box question, the answers resulted in the following graphic (the corresponding questionnaires and the resulting statistical tables are available in the corresponding annexes):

2.1) Do you recommend the use of Generator Fire Protection?



Six out of 10 (60%) of the participant manufacturers do not recommend the use of GFP.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.1.1-

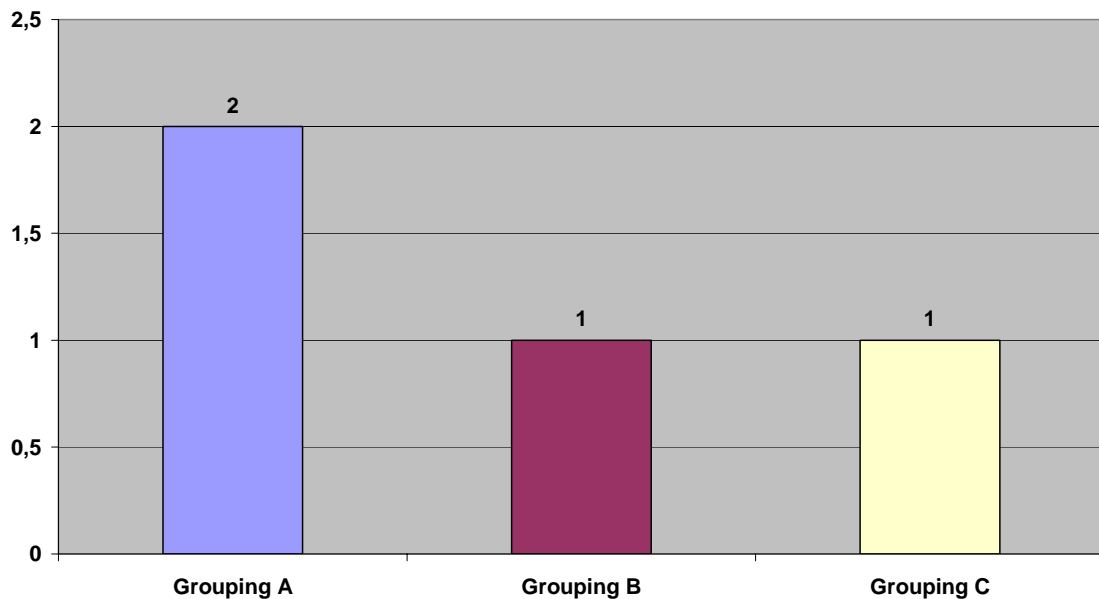
2.1.1) If yes, which type?

This exploratory question was stated as an open question and the results are show in the analysis below.

We remind that, as an open question allows, we got several different answers which were classified in “**Groupings**” in order to allow a statistical survey on the answers tendency (from time to time we will remind that the original answers as well as the complete statistical tables of the items concerned herewith are available on the corresponding annexes).

2.1.1) From the generator manufacturer's standpoint, do you recommend the use of Generator Fire Protection? If yes, which type?		
Grouping A	CO2	2
Grouping B	Water	1
Grouping C	Depends of Customer's location	1
Grouping D	Blank	6
Total of answered questions		10

2.1.1 - Do you recommend the use of Generator Fire Protection? If yes, which type?



This analysis shows a preference for CO2 systems, but a close look on some answers shows details to be considered:

In the Grouping **C** the Manufacturer EMP001 from Switzerland commented that: “*If acceptable by client we recommend Inergen (Switzerland). For Asia Water spray is preferred then CO2*”. This is in line with the crescent use of Inergen in Europe.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.1.2 -

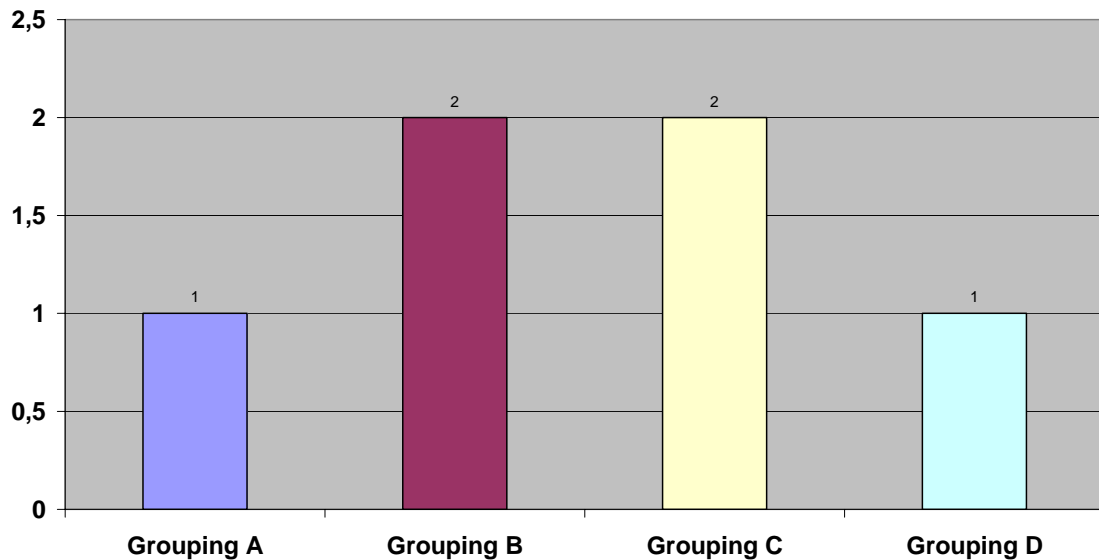
2.1.2) If not, please state your reasons.

This open question allowed making a categorization as follows:

2.1.2) From the generator manufacturer's standpoint, do you recommend the use of Generator Fire Protection? If not, please state your reasons.		
Grouping A	No tradition on using GFP	1
Grouping B	The use o GFP depends upon customer's decision	2
Grouping C	Use of self-extinguishing or non-flammable insulation material	2
Grouping D	State of the art insulation does not avoid risk of damages	1

Grouping E	Blank	4
Total of answered questions		10

2.1.2- Do you recommend the use of Generator Fire Protection? If not, please state your reasons.



Here some interesting additional comments were given. Here some of them:

For the Grouping **A** - No tradition on using GFP – the Manufacturer EMP004 from Norway added the following comment: *“There is no tradition for this among our customers. New insulation materials are considered to be self- extinguishable.”*

In the Grouping **B** - The use o GFP depends upon customer's decision - the Canadian Manufacturer EMP050 explained the following: *“All parts of the generator are made of self extinguishing material. The generator is also very sensitively protected by electronic relays as differential earth fault, over current protection, etc. our company is of the general opinion that the fire extinguishing system for generators is a matter between the customer and the insurance company for his machinery.”*

For the Grouping **C** - Use of self-extinguishing or non-flammable insulation material - the comment form the Japanese Manufacturer EMP044 is as follows: *“Self-extinguishing coils are used for our generators.”*

Finally for the Grouping **D** - State of the art insulation does not avoid risk of damages - an Austrian Manufacturer EMP046 wrote the following: *“When using state of the art insulation material risk of major damages is not zero but low. Certain risk of not detecting/wrong detection is still given which would lead to major disturbance in operation.”*

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.2 -

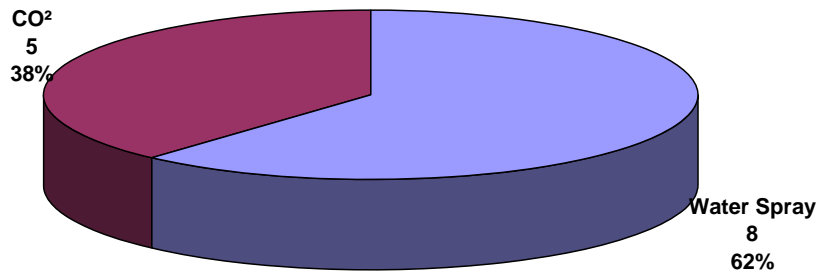
2.2) From your experience, which is the type of generator fire extinguishing method more frequently used nowadays?

- CO₂
- Water Spray
- Inergen
- Other

If other please specify:

This question has a multiple choice check-box part complemented by an open type question. Starting with the check-box part we got the following result:

2.2 - From your experience, which is the type of generator fire extinguishing method more frequently used nowadays?



It is interesting to observe that there is a difference between the Manufacturer's perceptions of the more frequently used method and the method they recommend. On the other hand the other alternatives proposed that was Inergen did not receive a mention, but from the Users' side this extinguishing media got several mentions.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If other please specify): got no answers.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.2.1 -

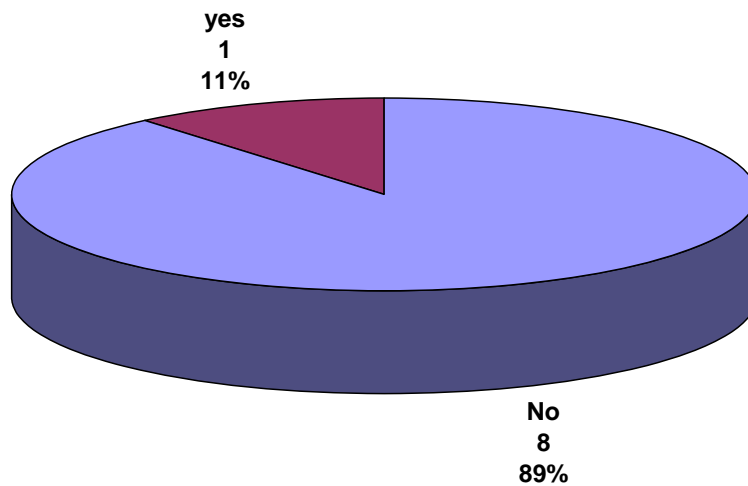
2.2.1) Any change towards the former trend?

- Yes - No

If yes, please state it here:

This is also a composed question with check-box and exploratory open question. The result of the check-box question's result is the following:

2.2.1 - Any change towards the former trend?



[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (if yes, please state it here): got one answer from the Japanese Manufacturer EMP044 telling: "Water Spray to CO2"; no other Manufacturer stated a comment.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

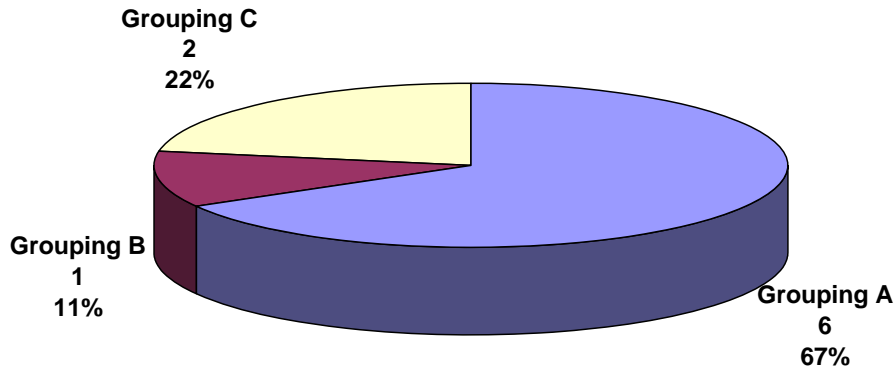
E 2.3 - Which Standards do you apply in the design of the fire protection of your generators?

2.3) Which Standards do you apply in the design of the fire protection of your generators?

This is a pure open question that showed the following results:

2.3) Which Standards do you apply in the design of the fire protection of your generators?		
Grouping A	NFPA	6
Grouping B	Countries own Standards (not NFPA)	1
Grouping C	Depends of customer's specifications	2
Grouping D	Not Applicable	1
Total of answered questions		10

2.3 - Which Standards do you apply in the design of the fire protection of your generators?



Also for the Manufacturers the American Standards NFPA are the most used.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

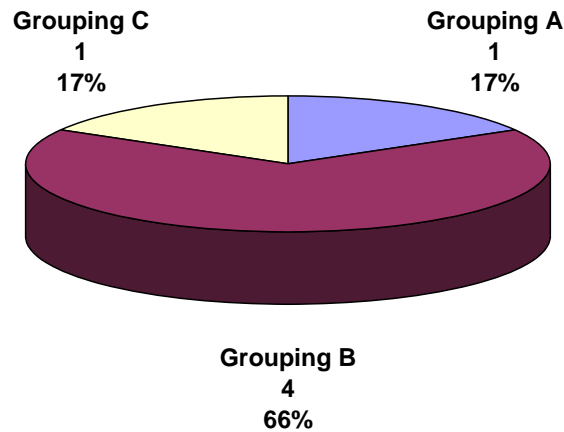
E 2.3.1 - Are there critical items in the application of these Standards that require special attention?

2.3.1) Are there critical items in the application of these Standards that require special attention?

This is also a pure open question:

2.3.1) Are there critical items in the application of these Standards that require special attention?		
Grouping A	Correct calculations	1
Grouping B	There are no critical items	4
Grouping C	CO2 in underground stations	1
Grouping D	Not applicable	1
Grouping E	Blank	3
Total of answered questions		10

2.3.1 - Are there critical items in the application of these Standards that require special attention?



On the Grouping **A** - Correct calculations – the Manufacturer EMP001 from Switzerland called the attention for: “*Correct computation of required water flow.*”
On the Grouping **C** - CO2 in underground stations – the Manufacturer EMP046 from Austria reminded that: “*CO2 systems are always critical in underground stations, therefore should be avoided in such applications.*”

[\[Back to Index\]](#) [\[Go to Annex\]](#)

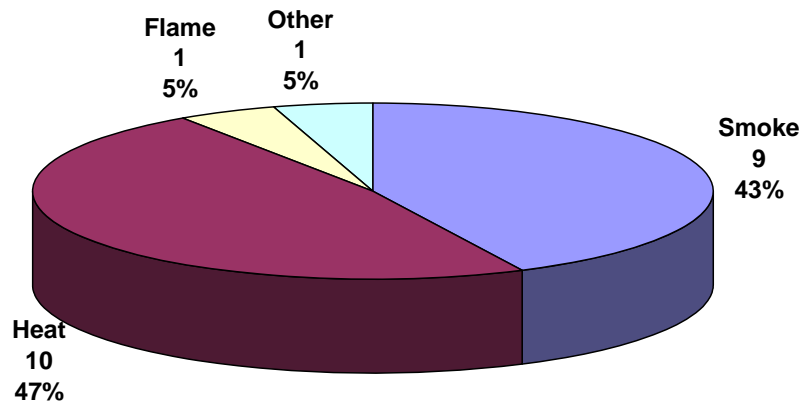
E 2.4 -

2.4) What is the state of the art in the detection in accordance to your experience?

- smoke
- heat
- flame
- other – please describe:

This is a check-box type question with an “other” alternative that results in an open question. The check-box question resulted in the following graphic:

2.4 - What is the state of the art in the detection in accordance to your experience?



[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (other-please describe here): only one Manufacturer, in this case the French company EMP003 pointed out the following: “In general we energize the fire protection only if two types of detectors are activated (smoke and temperature) or if smoke detector (or temperature detector) is activated at the same time as the electrical differential protection.”

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.4.1 -

2.4.1) Which are the types of detection devices you normally use and/or recommend?

This is a pure open question and all answers converged to “smoke and heat” detectors and here some of the comments are reproduced; the complete comments can be seen on the corresponding annex:

The French Manufacturer coded EMP003 commented the following: “*smoke detectors or temperatures detectors. Only one type of detector is not the signature of fire presence (temperature detector can be activated at stand still when the cooling is stopped, smoke detectors can be activated by presence of dust, especially*”.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

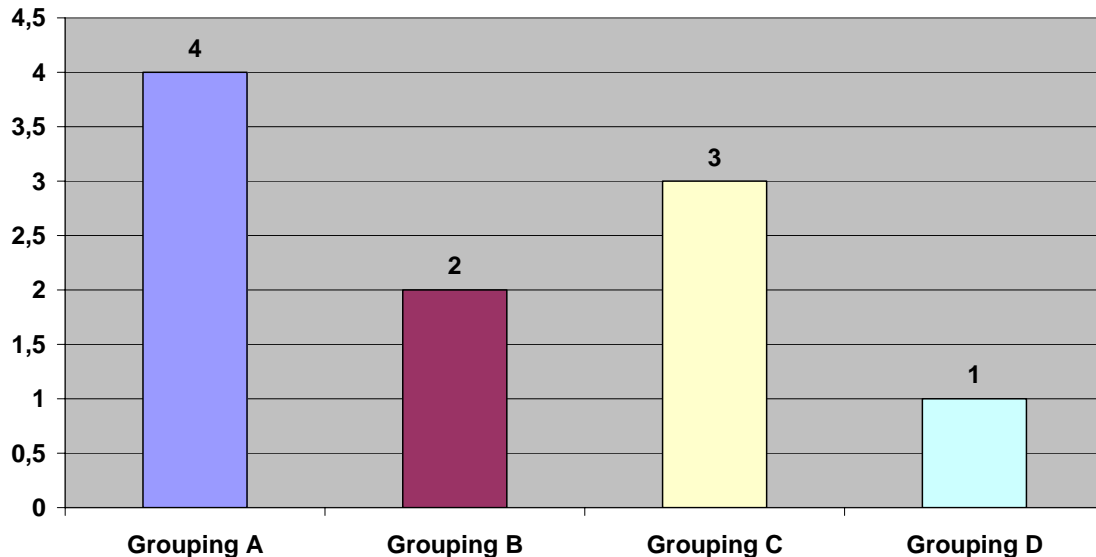
E 2.4.2 -

2.4.2) Do you recommend any specific detection and control system to minimize unwanted fire extinguishing system operation?

This is a pure open question and the answers allowed a categorized analysis which resulted as follows:

2.4.2) Do you recommend any specific detection and control system to minimize unwanted fire extinguishing system operation?		
Grouping A	Smoke and Thermal plus protection relay	4
Grouping B	Use different type of detectors	2
Grouping C	Nothing special	3
Grouping D	Depends on customer's decision	1
Total of answered questions		10

2.4.2 - Do you recommend any specific detection and control system to minimize unwanted fire extinguishing system operation?



This question was pointed out by the Users as one of their greatest concerns due to the implications inherent to risk situation to operators and to property caused by unwanted operation (release) of the GFP equipment. The Manufacturers show that they are aware of this issue and some offered their suggestions. Although the complete answers are available on the annex here a selection of the received answers:

On the Grouping A (Smoke and Thermal plus protection relay) got 4 answers and we point out the Chinese manufacturer EMP021 that wrote: "The fire extinguishing system will be released in case of:

- a) Some of settling smoke detectors actuated;
- b) Some of settling heat detectors actuated;
- c) Differential and or neutral protection already tripped off;
- d) Circuit breaker of high voltage side of main transformer and de-escalation breaker already tripped off."

This is a very complete position and is the trend of combined sensors and interlocking with the generator's electrical protection.

On the Grouping B (Use different type of detectors) the Canadian Manufacturer coded as EMP050 commented the following: "2 different types of detectors in series to avoid false detection".

The Grouping C (Nothing special) did not show any special comment, this group is composed by Manufacturers that do no issue recommendations.

On the Grouping D (Depends on customer's decision) the Austrian Manufacturer, coded EMP046, commented the following: "Applied system mainly depends on customer's overall plant fire protection philosophy."

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.5 -

2.5) Does your company design generators suited to any of the existing fire extinguishing media (CO ₂ , Water Spray, Halon substitutes, etc.), or there are
--

limitations from your side?

- No limitations - Yes, there are some limitations

The answers received 9 answers “No limitations” only the Japanese Manufacturer coded EMP044 selected the “Yes, there are some limitations” alternative. Thus from the Manufacturer’s side there should be no problems with the use of water as extinguishing media, but it is known that stator core corrosion may appear some time after the use of water.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.5.1 -

2.5.1) Should you have limitations, please state them here:

This exploratory open question, as expected had only one answer from the Japanese Manufacturer EMP044, that stated the following: *“In case of gas type fire extinguishing media such as CO₂ or Halon is applied, air tightness of the generator housing is required by customers.”* We add to this concern the question related to the inrush pressure during the CO₂ short time deployment – in this case it may be that special pressure relief openings have to be installed in order to avoid damages in the housing openings to keep the same sound in order not to be torn away; by this means the required CO₂ concentration during the specified time can be guaranteed.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.6 -

2.6) From the fire protection standpoint, the generator and its housing have to be considered as a whole in the design when fire extinguishing is to be installed, in order to guarantee the system’s functionality and efficiency. Considering this fact are you always informed by the purchaser from the beginning of the generator’s design of the future application of a specific generator fire protection method?

- Yes - No

Any comments? Please state them here:

This question is a two stages one, at first one check-box question then an open question requesting for comments.

The check-box part showed that in this case only the Norwegian Manufacturer coded EMP004 answered with “NO”, this shows that the majority of clients do inform the use of GFP at the beginning of the project, this transfers some responsibility to the Manufacturers.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (Any comments? Please state them here): we got two answers as follows:

The Swiss Manufacturer coded EMP001 explained that: *“Generally yes, but not with enough details.”*

And the French Manufacturer coded EMP003, explained that: *“generally the fire protection is in the scope of the generator manufacturer (for new installation) and design of the capacity of fire protection depends directly on the size of the generator.”*

[\[Back to Index\]](#) [\[Go to Annex\]](#)

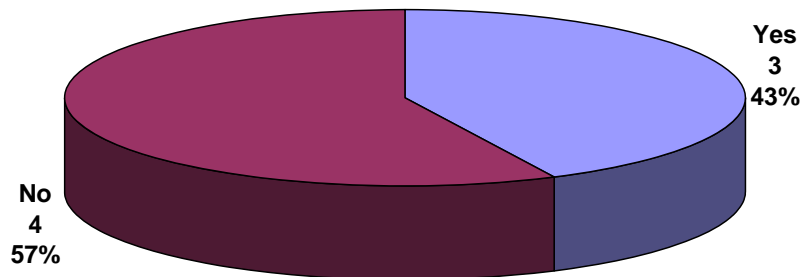
E 2.6.1 -

2.6.1) Are you requested to participate in the definition of the fire extinguishing system to be applied in one generator of your manufacture?

- Yes - No

Any comments? Please state them here:

2.6.1 - Are you requested to participate in the definition of the fire extinguishing system to be applied in one generator of your manufacture?



This question had 3 blank answers.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (Any comments? Please state them here):

Again two additional explanations were received, as follows:

The French Manufacturer, coded as EMP003, stated: *“My answer is Yes as the fire protection is generally in the scope of the generator manufacturer but it is also No if not in the scope it is rarely stated what will be the generator fire protection in the future.”*

The Austrian manufacturer, coded as EMP046, stated that: *“Sometimes we are involved, sometimes the system is already defined by the customer”*

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.6.2 -

2.6.2) Did you have to adapt a ready generator design to a specific fire extinguishing system?

- Yes - No

If yes, when:

- before manufacture

- during manufacture

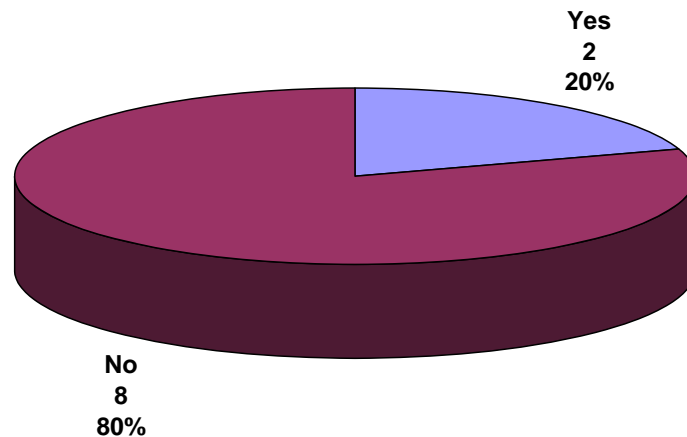
- after erection?

Any comments? Please state them here:

This question was stated in three stages: two check-boxes and one explanatory open question.

First check-box question (Yes or No): gave the following result:

2.6.2 - Did you have to adapt a ready generator design to a specific fire extinguishing system?



[\[Back to Index\]](#) [\[Go to Annex\]](#)

Second check-box question (alternatives: before manufacture, during manufacture and after erection): gave the following result: two Manufacturers, the Swiss coded EMP001 and the Austrian coded EMP046 checked the answer: “before manufacture”; it means the design was ready and had to be altered in order to comply with a late notice about the GFP installation.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (Any comments? Please state them here): we got three contributions, as follows:

The Swiss Manufacturer, coded EMP001, explained the following: “It is recommended to coordinate the needed piping system with the pipes and cables of all other auxiliary components at an early stage of the project.”

The French Manufacturer, coded EMP003, added the following explanation: “We adapt the fire extinguishing system to the dimensions of the generator.”

And the Canadian Manufacturer, coded EMP050, wrote: “CO2 and Halon need special requirements for the housing and bearings (pressure on both sides of the sump).”

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.7 -

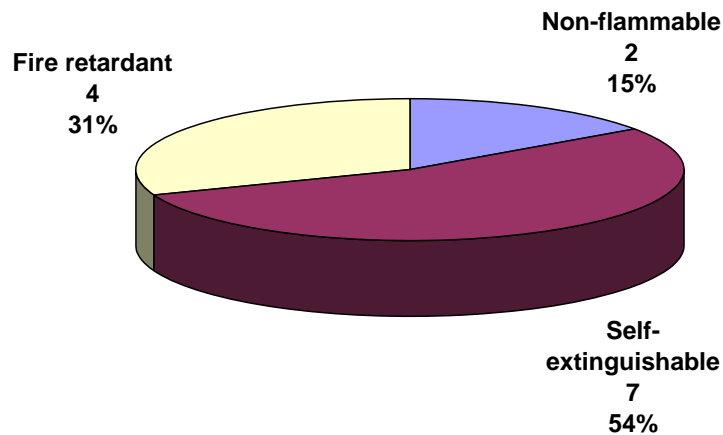
2.7) Modern insulation materials are mostly considered to be non-flammable, fire retardant or self-extinguishable. Since these aspects are subject to test conditions that sometimes diverge from actual accident situations, please check how the insulation material you use can be classified:

- flammable
- non-flammable
- fire retardant
- self-extinguishable

Any comments? Please state them here:

This question is composed by a check-box part and an exploratory question. Starting with the check-box question, a multiple choice between the following alternatives: flammable, non-flammable, fire retardant and self-extinguishable. The result is as follows:

2.7 - How the insulation material you use can be classified?



In this case three Manufacturers checked two categories each, as follows:

- The American company coded EMP057 indicated: fire retardant and self-extinguishable.
 - The Chinese manufacturer coded EMP021 indicated: non-flammable and fire retardant.
 - The Austrian Manufacturer coded EMP046 indicated: fire retardant and self-extinguishable.
- More details can be seen on the corresponding annex.

In fact none of the participant Manufacturers indicated flammable; this indicated that all do use modern type insulation material, but it may be that these manufacturers are not sticking to the concepts that are stated in the corresponding standards.

Here it may be interesting to point out some technical aspects concerning this particular subject. Let's start with some brief definitions according to former classification:

Non-flammable:

Material that exposed to the source of heat, direct flame or incandescent resistance does not come into combustion.

Self-extinguishable:

Material that exposed the source of heat, direct flame or incandescent resistance bursts into flame, which in a certain time (usually in seconds) is extinguished.

Fire-retardant:

Material that exposed the source of heat, direct flame or incandescent resistance bursts into flame is not extinguished and put the speed of burning is minimized.

Talking about insulation, Class F 155 ° C and Class H 180 ° C are only the temperatures of insulating materials in rotating machines under continuous operation; they do not have any necessary relation to flammability. The flammability characteristics are defined by the material used and is specified, for instance, in standards as NEMA, ASTM, IEC and test standard as UL under defined circumstances.

The new flammability classification is defined by the CEI IEC INTERNATIONAL STANDARD 60893-3-2 revision 2003-11, and also in a similar way by the UL94

Flammability Standard. The classification normally applied to hydro generators is the “V-0” grade (that stands for Vertical Testing grade “0” – there are grades for Horizontal Testing for other purposes). The V-0 requires the following from the testing probe:

- Specimens must not burn with flaming combustion for more than 10 seconds after either test flame application.
- Total flaming combustion time must not exceed 50 seconds for each set of 5 specimens.
- Specimens must not burn with flaming or glowing combustion up to the specimen holding clamp.
- Specimens must not drip flaming particles that ignite the cotton.
- No specimen can have glowing combustion remain for longer than 30 seconds after removal of the test flame.

On the “Table 5- Property requirements” of the CEI IEC INTERNATIONAL STANDARD 60893-3-2 revision 2003-11, the different material conditions are described. This includes the “Flammability Category”. For instance for the material coded “EP CP 201”, “EP GC 202” and “EP GC 204” [EP= Epoxy, CP= Cellulosic paper, GC= Woven glass cloth and so on] the flammability is defined as V-0, but an important note is added concerning the flammability indication:

QUOTE

*The small-scale laboratory test used in this standard for assigning a flammability category is primarily for monitoring consistency of production of laminates. **The results so obtained should not in any circumstances be considered as an overall indication of the potential fire hazards presented by these laminates under actual conditions of use.***

UNQUOTE

No manufacturer is allowed to state that their machines are “*non flammable*” due to the fact that they use V-0 grade insulating components. The Standards do not allow this type of statement. But in the mean time a myth was created about machines being non flammable, and this situation is leading many Users to skip the use of any GFP in their plants. Manufacturers that proceed this way may become liable towards their customers in the case of a fire accident.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (Any comments? Please state them here):

Only the Chinese Manufacturer coded EMP021 commented that: “*As the reasons above, we recommend not to install the fire extinguishing device for small and medium*”

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.7.1 -

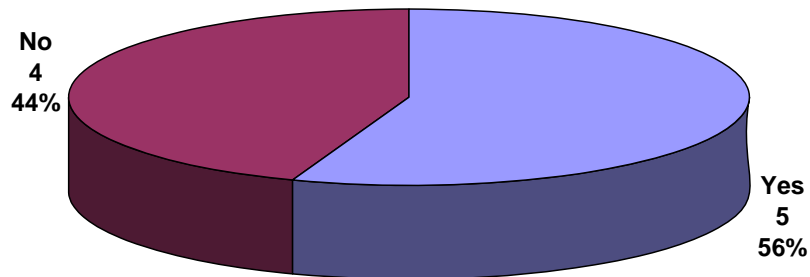
2.7.1) Do you test the flammability conditions of the materials you use by yourself?

- Yes - No

If not, who does these tests for you and under which conditions?

This is a combined question, starting with the check-box part (Yes/No) we got the following graphic:

2.7.1 - Do you test the flammability conditions of the materials you use by yourself?



The Chinese Manufacturer coded EMP021 did leave this question blank.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If not, who does these tests for you and under which conditions?):

In this case we got two comments, they are the following:

- The Norwegian Manufacturer coded EMP004 said: *"No specific tests performed"*.
- The Austrian Manufacturer coded EMP024 explained that: *"Internal tests and also tests by various external institutes."*

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.8 -

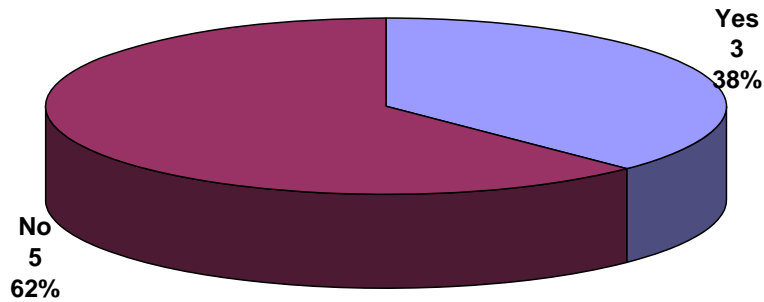
2.8) Has any of the hydro generators you manufactured suffered a fire accident?

- Yes - No

If yes, please state some details here:

This is a combined question, and the result of the check-box (Yes/No) part is shown in the graphic:

2.8 - Has any of the hydro generators you manufactured suffered a fire accident?



Two Manufacturers did not answer leaving the check-boxer unmarked.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If yes, please state some details here) resulted in two contributions:

- The Norwegian Manufacturer coded EMP004 told the following: "*Several incidents due to electrical faults*"
- The Autrian manufacturer coded EMP046, explained: "*Happened more than 15 years ago.*"

From this side we got little information about fire accidents seen from Manufacturer's perspective.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.8.1 -

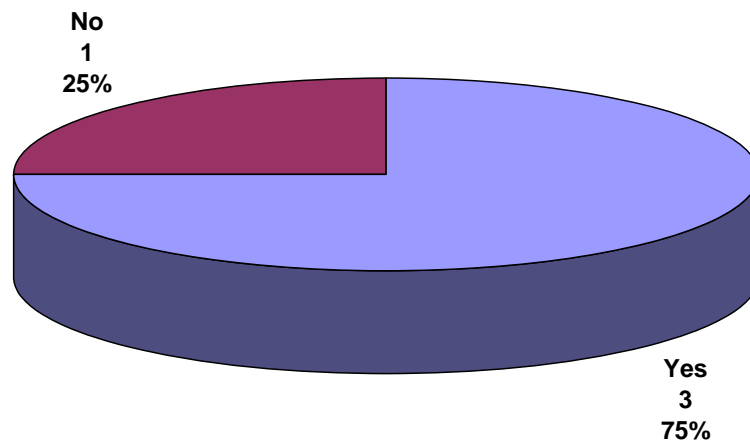
2.8.1) Was the origin of the fire determined?

- Yes - No

If yes, please state some details here:

The check-box part of this question resulted in the following graphic:

2.8.1 - Was the origin of the fire determined?



In this case six Manufacturers left the check-boxes unmarked.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If yes, please state some details here), we got three results, as follows:

- The Swiss Manufacturer coded EMP001 explained that: *“Generator circuit breaker was did not operate correctly. Generator remained connected to grid and excitation was turned off. The machine was operating in inadmissible asynchronous mode.”*
- The Norwegian Manufacturer coded EMP004 wrote: *“Short-circuits, earth faults”*
- The Austrian Manufacturer coded EMP046 , wrote: *“Origin in overloaded soft-soldered winding connections.”*

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.8.2 -

2.8.2) Was the generator equipped with fire protection system?

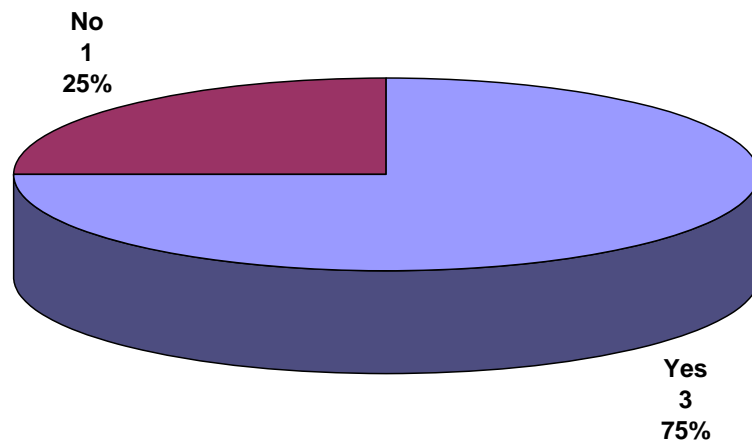
- Yes - No

If yes, please state which type here (CO₂, water-spray, etc.):

Following the four Manufacturers that are following this tread because they reported an fire accident in one of their supplied machines we have this combined check-box and auxiliary open question.

The check-box question gave the following result:

E 2.8.2 - Was the generator equipped with fire protection system?



Remembering: 6 Manufacturers did not participate at this stage.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If yes, please state which type here - CO₂, water-spray, etc.): the Swiss Manufacturer coded EMP001 and the Austrian Manufacturer coded EMP046 reported that the generators were protected with CO₂, the Norwegian Manufacturer coded EMP004 left his answer blank and the Japanese Manufacturer coded EMP044 answered N.A that does not make much sense in this particular case.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.8.2.1 -

2.8.2.1) Do you know if it did work properly?

- Yes - No

If yes, please state some details here:

This is also a combined question and the check-box part (Yes/No) had the following answers: The Swiss Manufacturer coded EMP001 and the Japanese Manufacturer coded EMP044 answered "Yes" and the other two, the Norwegian coded EMP004 and the Austrian coded EMP044, answered "No", the other six remained out of this question too.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If yes, please state some details here) the only answer received was from the Swiss Manufacturer, coded EMP001, that answered : "The system worked properly. However the cause of the fire was not eliminated. After some time, the CO₂ had vanished and the generator restarted to burn."

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.8.3 -

2.8.3) Do you have any specific comment and/or information about the damages that occurred?

This is a pure open question and no categorized survey was possible, but the received answers are important because they transmit a practical experience. This answers are:

- The Swiss Manufacturer coded EPM001 explained that: *“Further equipment in the power station got damaged.”*
- The Norwegian Manufacturer coded EMP004 explained that: *“Fire extinguishes when electrical fault is disconnected, however, lots of smoke, and power station must be evacuated for a long time”*
- The Austrian Manufacturer coded EMP046 explained that: *“We have discontinued the use soft soldered connections about 15 years ago.”*
- The Japanese Manufacturer coded EMP044 indicated N.A. again.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.8.4 -

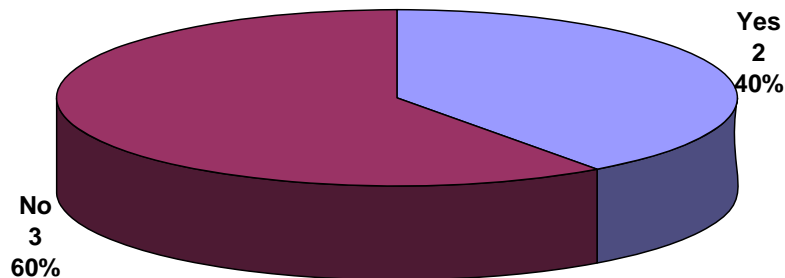
2.8.4) Would you like to state a general recommendation considering generator fire protection?

- Yes - No

If yes, please state it here:

This is a combined question, and the check-box result is the following:

2.8.4 - Would you like to state a general recommendation considering generator fire protection?



The other five manufacturers did not check a box.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If yes, please state it here) and we got two important contributions:

- From the Austrian Manufacturer coded EMP046: *“Clean conditions, state of the art insulation material, a proper ventilation system, brazed winding connections are essential for safe operation. Fire protection is recommended for old generators (old insulation systems, soft soldered connections, etc.)”*
- From the Canadian Manufacturer coded EMP050: *“Fire extinguishing is not required. Are recommended: fire detection, fire resistant doors.”*

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.9 -

2.9) Besides the design and production of new generators, does your company participate in the refurbishment and/or maintenance area?

- Yes - No

If yes, please state some details here:

This is a combined question and the check-box part showed the following result: nine Manufacturers answered "Yes" and on did not check any box.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If yes, please state some details here): as answer four Manufacturers confirmed that they are also active in the refurbishment field. More details can be seen on the corresponding annex.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.9.1 -

2.9.1) If yes, does it include the fire extinguishing systems?

- Yes - No

If yes, please state some details here:

This is a combined question. On the check-box (Yes/No) part four Manufacturers answered "Yes".

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If yes, please state some details here): we got the following answers:

-The French Manufacturer coded EMP003 said: "Generally the fire protection system is already installed in the power station, sometimes we are asked to refurbish it."

-The Japanese Manufacturer coded EMP034 said: "Replacement of existing fire extinguishing system"

-The Canadian Manufacturer coded EMP050 said: "Sometimes in major rehabs"

[\[Back to Index\]](#) [\[Go to Annex\]](#)

E 2.10 - According to your opinion, is there any question that is missing in this part of the questionnaire?

2.10) 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:

This is a combined question. The check-box (Yes/No) part got 8 answers "No" and two Manufacturers left blank.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

Open question analysis results (If yes, please state it here): since there was no answer "Yes" no answer on the check box part, no answer was stated on the open question part.

[\[Back to Index\]](#) [\[Go to Annex\]](#)

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

E 2.1 Check-Box

Question	Company	Result
		Answer
2.1) From the generator manufacturer's standpoint, do you recommend the use of Generator Fire Protection?	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	Yes
	EMP003 (France)	Yes
	EMP004 (Norway)	No
	EMP057 (United States)	No
	EMP021 (China)	Yes
	EMP034 (Japan)	No
	EMP044 (Japan)	No
	EMP046 (Austria)	No
	EMP050 (Canada)	No

[\[Back to Question\]](#)

E 2.1.1 Open question

2.1) From the generator manufacturer's standpoint, do you recommend the use of Generator Fire Protection?			
Question	Company	Result	Grouping
		Answer	
2.1.1) If yes, which type?	EMP001 (Switzerland)	If acceptable by client we recommend Inergen (Switzerland). For Asia Water spray is preferred then CO2.	C
	EMP002 (Brazil)	CO2	A
	EMP003 (France)	CO ²	A
	EMP004 (Norway)	Em Branco	D
	EMP057 (United States)	Em Branco	D
	EMP021 (China)	For huge machines we recommend to use water spray type.	B
	EMP034 (Japan)	Em Branco	D
	EMP044 (Japan)	Em Branco	D
	EMP046 (Austria)	Em Branco	D
	EMP050 (Canada)	Em Branco	D
Summary			
Grouping	Legend		Quantity
Grouping A	CO2		2
Grouping B	Water		1
Grouping C	Depends of Customer's location		1
Grouping D	Blank		6
Total of answered questions			10

[\[Back to Question\]](#)

E 2.1.2 Open question

2.1) From the generator manufacturer's standpoint, do you recommend the use of Generator Fire Protection?			
Question	Company	Result	Grouping
		Answer	
2.1.2) If not, please state your reasons.	EMP001 (Switzerland)	Em Branco	E
	EMP002 (Brazil)	Em Branco	E
	EMP003 (France)	Em Branco	E
	EMP004 (Norway)	There is no tradition for this among our customers. New insulation materials is considered to be self- extinguishable.	A
	EMP057 (United States)	The generator is protected by relays and the fire extinguishing system for generators could be decided by the customer for the whole power station.	B
	EMP021 (China)	Em Branco	E
	EMP034 (Japan)	We don't use flammable material.	C
	EMP044 (Japan)	Self-extinguishing coils are used for our generators.	C
	EMP046 (Austria)	When using state of the art insulation material risk of major damages is not zero but low. Certain risk of not detecting/wrong detection is still given which would lead to major disturbance in operation.	D
	EMP050 (Canada)	All parts of the generator are made of self extinguishing material. The generator is also very sensitively protected by electronic relays as differential earthfault, over current protection, etc. Voith Siemens is of the general opinion that the fire extinguishing system for generators is a matter between the customer and the insurance company for his machinery.	B
Summary			
Grouping	Legend		Quantity
Grouping A	No tradition on using GFP		1
Grouping B	The use o GFP depends upon customer's decision		2
Grouping C	Use of self-extinguishing or non-flammable insulation material		2
Grouping D	State of the art insulation does not avoid risk of damages		1
Grouping E	Blank		4
Total of answered questions			10

[\[Back to Question\]](#)

E 2.2 Check-box

Question	Company	Result
		Answer
2.2) From your experience, which is the type of generator fire extinguishing method more frequently used nowadays?	EMP001 (Switzerland)	Water Spray
	EMP002 (Brazil)	CO ²
	EMP003 (France)	CO ²
	EMP003 (France)	Water Spray
	EMP004 (Norway)	Water Spray
	EMP057 (United States)	Water Spray
	EMP021 (China)	Water Spray
	EMP034 (Japan)	CO ²
	EMP034 (Japan)	Water Spray
	EMP044 (Japan)	CO ²

	EMP046 (Austria)	CO ²
	EMP046 (Austria)	Water Spray
	EMP050 (Canada)	Water Spray

[\[Back to Question\]](#)

E 2.2 Open question

2.2) From your experience, which is the type of generator fire extinguishing method more frequently used nowadays?		
Question	Company	Result
		Answer
If other please specify:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.2.1 Check-box

2.2) From your experience, which is the type of generator fire extinguishing method more frequently used nowadays?		
Question	Company	Result
		Answer
2.2.1) Any change towards the former trend?	EMP001 (Switzerland)	No
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	No
	EMP004 (Norway)	No
	EMP057 (United States)	No
	EMP021 (China)	No
	EMP034 (Japan)	No
	EMP044 (Japan)	Yes
	EMP046 (Austria)	No
	EMP050 (Canada)	No

[\[Back to Question\]](#)

E 2.2.1 Open question

2.2.1) Any change towards the former trend?		
Question	Company	Result
		Answer
If yes, please state it here:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Em Branco

	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Water Spray to CO2
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.3 Open question

Question	Company	Result	Grouping
		Answer	
2.3) Which Standards do you apply in the design of the fire protection of your generators?	EMP001 (Switzerland)	NFPA (international, with country specific sub chapters).	A
	EMP002 (Brazil)	NFPA	A
	EMP003 (France)	NFPA	A
	EMP004 (Norway)	N/A	D
	EMP057 (United States)	NFPA	A
	EMP021 (China)	For water spray we apply GB50219, CO2 gas GB50193. All they are National standard.	B
	EMP034 (Japan)	It depends on the requirement of customer's specification.	C
	EMP044 (Japan)	NFPA standard	A
	EMP046 (Austria)	Depends on customer specification.	C
	EMP050 (Canada)	NFPA	A

Summary

Grouping	Legend	Quantity
Grouping A	NFPA	6
Grouping B	Countries own Standards (not NFPA)	1
Grouping C	Depends of customer's specifications	2
Grouping D	Not Applicable	1
Total of answered questions		10

[\[Back to Question\]](#)

E 2.3.1 Open question

2.3) Which Standards do you apply in the design of the fire protection of your generators?			
Question	Company	Result	Grouping
		Answer	
2.3.1) Are there critical items in the application of these Standards that require special attention?	EMP001 (Switzerland)	Correct computation of required water flow.	A
	EMP002 (Brazil)	Em Branco	E
	EMP003 (France)	Em Branco	E
	EMP004 (Norway)	N/A	D
	EMP057 (United States)	Em Branco	E
	EMP021 (China)	No	B
	EMP034 (Japan)	No, there are no critical items.	B
	EMP044 (Japan)	No	B
	EMP046 (Austria)	CO2 systems are always critical in underground stations, therefore should be avoided in such applications.	C
	EMP050 (Canada)	No	B

Summary		
Grouping	Legend	Quantity
Grouping A	Correct calculations	1
Grouping B	There are no critical items	4
Grouping C	CO2 in underground stations	1
Grouping D	Not applicable	1
Grouping E	Blank	3
Total of answered questions		10

[\[Back to Question\]](#)

E 2.4 Check- Box

Question	Company	Result
		Answer
2.4) What is the state of the art in the detection in accordance to your experience?	EMP001 (Switzerland)	smoke
	EMP001 (Switzerland)	heat
	EMP002 (Brazil)	heat
	EMP003 (France)	smoke
	EMP003 (France)	heat
	EMP003 (France)	other
	EMP004 (Norway)	smoke
	EMP004 (Norway)	heat
	EMP057 (United States)	smoke
	EMP057 (United States)	heat
	EMP057 (United States)	flame
	EMP021 (China)	smoke
	EMP021 (China)	heat
	EMP034 (Japan)	smoke
	EMP034 (Japan)	heat
	EMP044 (Japan)	smoke
	EMP044 (Japan)	heat
	EMP046 (Austria)	smoke
EMP046 (Austria)	heat	
EMP050 (Canada)	smoke	
EMP050 (Canada)	heat	

[\[Back to Question\]](#)

E 2.4 Open question

2.4) What is the state of the art in the detection in accordance to your experience?		
Question	Company	Result
		Answer
If other please describe:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	In general we energize the fire protection only if two types of detectors are activated (smoke and temperature) or if smoke detector (or temperature detector) is activated at the same time as the electrical differential protection.
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco

	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.4.1 Open question

2.4) What is the state of the art in the detection in accordance to your experience?			
Question	Company	Result	Grouping
		Answer	
2.4.1) Which are the types of detection devices you normally use and/or recommend?	EMP001 (Switzerland)	Combined smoke and heat detectors.	A
	EMP002 (Brazil)	TERMICO, TERMOVELOCIMÉTRICO	A
	EMP003 (France)	smoke detectors or temperatures detectors. Only one type of detector is not the signature of fire presence (temperature detector can be activated at stand still when the cooling is stopped, smoke detectors can be activated by presence of dust, especially	A
	EMP004 (Norway)	Heat detection, 4 - 6 detectors inside generator stator upper part, equally distributed around the circumference	A
	EMP057 (United States)	Smoke and heat	A
	EMP021 (China)	Normally we use smoke detector with ionization type and heat detector with temperature fixation type.	A
	EMP034 (Japan)	Smoke and heat.	A
	EMP044 (Japan)	Smoke and heat	A
	EMP046 (Austria)	Smoke detectors are recommended, but customers also want heat sensors.	A
	EMP050 (Canada)	Smoke and heat	A
Summary			
Grouping	Legend		Quantity
Grouping A	Smoke and heat		10

[\[Back to Question\]](#)

E 2.4.2 Open question

2.4) What is the state of the art in the detection in accordance to your experience?			
Question	Company	Result	Grouping
		Answer	
2.4.2) Do you recommend any specific detection and control system to minimize unwanted fire extinguishing system operation?	EMP001 (Switzerland)	More than one detector of each type has to tripp an alarm. Alarms could be correlated with other signals like unusual temperature rise in winding for example.	A
	EMP002 (Brazil)	NO	C

	EMP003 (France)	We normally recommend now launching of fire protection by simultaneous actuation of smoke /d temperature detectors with the electrical differential protection. Actuation of both types of detectors (temperature and smoke) can release the fire protection in	A
	EMP004 (Norway)	NO	C
	EMP057 (United States)	use different types of detectors	B
	EMP021 (China)	The fire extinguishing system will be released in case of:a)Some of settling smoke detectors actuated;b)Some of settling heat detectors actuated;c)Differential and or neutral protection already tripped off;d)Circuit braeker of high votage side of main transformer and deescalation breaker already tripped off.	A
	EMP034 (Japan)	Differential relay	A
	EMP044 (Japan)	Nothing special.	C
	EMP046 (Austria)	Applied system mainly depends on customer's overall plant fire protection philosophy.	D
	EMP050 (Canada)	2 different types of detectors in series to avoid false detection	B
Summary			
Grouping	Legend		Quantity
Grouping A	Smoke and Termal plus protection relay		4
Grouping B	Use different type of detectors		2
Grouping C	Nothing special		3
Grouping D	Depends on customer's decision		1
Total of answered questions			10

[\[Back to Question\]](#)

E 2.5 Check-box

Question	Company	Result
		Answer
2.5) Does your company design generators suited to any of the existing fire extinguishing media (CO², Water Spray, Halon substitutes, etc.), or there are limitations from your side?	EMP001 (Switzerland)	No limitations
	EMP002 (Brazil)	No limitations
	EMP003 (France)	No limitations
	EMP004 (Norway)	No limitations
	EMP057 (United States)	No limitations
	EMP021 (China)	No limitations
	EMP034 (Japan)	No limitations
	EMP044 (Japan)	Yes, there are some limitations
	EMP046 (Austria)	No limitations
	EMP050 (Canada)	No limitations

[\[Back to Question\]](#)

E 2.5.1 Open question

2.5) Does your company design generators suited to any of the existing fire extinguishing media (CO², Water Spray, Halon substitutes, etc.), or there are limitations from your side?

Question	Company	Result
		Answer
2.5.1) Should you have limitations, please state them here:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	In case of gas type fire extinguishing media such as CO2 or Halon is applied, air tightness of the generator housing is required by customers.
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.6 Check-box

Question	Company	Result
		Answer
2.6) From the fire protection standpoint, the generator and its housing have to be considered as a whole in the design when fire extinguishing is to be installed, in order to guarantee the system's functionality and efficiency. Considering this fact are you always informed by the purchaser from the beginning of the generator's design of the future application of a specific generator fire protection method?	EMP003 (France)	Em Branco
	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	Yes
	EMP004 (Norway)	No
	EMP057 (United States)	Yes
	EMP021 (China)	Yes
	EMP034 (Japan)	Yes
	EMP044 (Japan)	Yes
	EMP046 (Austria)	Yes
	EMP050 (Canada)	Yes

[\[Back to Question\]](#)

E 2.6 Open question

2.6) From the fire protection standpoint, the generator and its housing have to be considered as a whole in the design when fire extinguishing is to be installed, in order to guarantee the system's functionality and efficiency. Considering this fact are you always informed by the purchaser from the beginning of the generator's design of the future application of a specific generator fire protection method?		
Question	Company	Result
Any comments? Please state them here:	EMP001 (Switzerland)	Generally yes, but not with enough details.
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	generally the fire protection is in the scope of the generator manufacturer (for new installation) and design of the capacity of fire protection depends directly on the size of the generator.
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Em Branco

	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.6.1 Check-box

2.6) From the fire protection standpoint, the generator and its housing have to be considered as a whole in the design when fire extinguishing is to be installed, in order to guarantee the system's functionality and efficiency. Considering this fact are you always informed by the purchaser from the beginning of the generator's design of the future application of a specific generator fire protection method?

Question	Company	Result
		Answer
2.6.1) Are you requested to participate in the definition of the fire extinguishing system to be applied in one generator of your manufacture?	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	No
	EMP003 (France)	Em Branco
	EMP004 (Norway)	No
	EMP057 (United States)	No
	EMP021 (China)	Yes
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	No
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Yes

[\[Back to Question\]](#)

E 2.6.1 Open question

2.6.1) Are you requested to participate in the definition of the fire extinguishing system to be applied in one generator of your manufacture?

Question	Company	Result
		Answer
Any comments? Please state them here:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	My answer is Yes as the fire protection is generally in the scope of the generator manufacturer but it is also No if not in the scope it is rarely stated what will be the generator fire protection in the future.
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Sometimes we are involved, sometimes the system is already defined by the customer
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.6.2 Check-box 1

2.6) From the fire protection standpoint, the generator and its housing have to be considered as a whole in the design when fire extinguishing is to be installed, in order to guarantee the system's functionality and efficiency. Considering this fact are you always informed by the purchaser from the beginning of the generator's design of the future application of a specific generator fire protection method?

Question	Company	Result
----------	---------	--------

		Answer
2.6.2) Did you have to adapt a ready generator design to a specific fire extinguishing system?	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	No
	EMP003 (France)	No
	EMP004 (Norway)	No
	EMP057 (United States)	No
	EMP021 (China)	No
	EMP034 (Japan)	No
	EMP044 (Japan)	No
	EMP046 (Austria)	Yes
	EMP050 (Canada)	No

[\[Back to Question\]](#)

E 2.6.2 Check-box 2

2.6.2) Did you have to adapt a ready generator design to a specific fire extinguishing system?		
Question	Company	Result
		Answer
If yes, when:	EMP001 (Switzerland)	before manufacture
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	before manufacture
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.6.2 Open question

2.6.2) Did you have to adapt a ready generator design to a specific fire extinguishing system?		
Question	Company	Result
		Answer
Any comments? Please state them here:	EMP001 (Switzerland)	It is recommended to coordinate the needed piping system with the pipes and cables of all other auxiliary components at an early stage of the project.
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	We adapt the fire extinguishing system to the dimensions of the generator.
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	CO2 and Halon needs special requirements for the housing and bearings (pressure on both sides of the sump).

[\[Back to Question\]](#)

E 2.7 check-box

Question	Company	Result
		Answer
<p>2.7) Modern insulation materials are mostly considered to be non-flammable, fire retardant or self-extinguishable. Since these aspects are subject to test conditions that sometimes diverge from actual accident situations, please check how the insulation material you use can be classified:</p>	EMP001 (Switzerland)	non-flammable
	EMP002 (Brazil)	self-extinguishable
	EMP003 (France)	self-extinguishable
	EMP004 (Norway)	self-extinguishable
	EMP057 (United States)	fire retardant
	EMP057 (United States)	self-extinguishable
	EMP021 (China)	non-flammable
	EMP021 (China)	fire retardant
	EMP034 (Japan)	fire retardant
	EMP044 (Japan)	self-extinguishable
	EMP046 (Austria)	fire retardant
	EMP046 (Austria)	self-extinguishable
	EMP050 (Canada)	self-extinguishable

[\[Back to Question\]](#)

E 2.7 Open question

<p>2.7) Modern insulation materials are mostly considered to be non-flammable, fire retardant or self-extinguishable. Since these aspects are subject to test conditions that sometimes diverge from actual accident situations, please check how the insulation material you use can be classified:</p>		
Question	Company	Result
		Answer
<p>Any comments? Please state them here:</p>	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	As the reasons above,we recommend not to install the fire extinguishing device for small and medium
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.7.1 Check-box

<p>2.7) Modern insulation materials are mostly considered to be non-flammable, fire retardant or self-extinguishable. Since these aspects are subject to test conditions that sometimes diverge from actual accident situations, please check how the insulation material you use can be classified:</p>		
Question	Company	Result
		Answer
<p>2.7.1) Do you test the flammability conditions of the materials you use by yourself?</p>	EMP021 (China)	Em Branco
	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	Yes
	EMP003 (France)	Yes
	EMP004 (Norway)	No
	EMP057 (United States)	No

	EMP034 (Japan)	Yes
	EMP044 (Japan)	Yes
	EMP046 (Austria)	No
	EMP050 (Canada)	No

[\[Back to Question\]](#)

E 2.7.1 Open question

2.7.1) Do you test the flammability conditions of the materials you use by yourself?		
Question	Company	Result
		Answer
If not, who does these tests for you and under which conditions?	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	No specific tests performed
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Internal tests and also tests by various external institutes.
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.8 Check-box

Question	Company	Result
		Answer
2.8) Has any of the hydro generators you manufactured suffered a fire accident?	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	No
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Yes
	EMP057 (United States)	No
	EMP021 (China)	Em Branco
	EMP034 (Japan)	No
	EMP044 (Japan)	No
	EMP046 (Austria)	Yes
	EMP050 (Canada)	No

[\[Back to Question\]](#)

E 2.8 Open question

2.8) Has any of the hydro generators you manufactured suffered a fire accident?		
Question	Company	Result
		Answer
If yes, please state some details here:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Several incidents due to electrical faults
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco

	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Happened more than 15 years ago.
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.8.1 Check-box

2.8) Has any of the hydro generators you manufactured suffered a fire accident?		
Question	Company	Result
		Answer
2.8.1) Was the origin of the fire determined?	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Yes
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	No
	EMP046 (Austria)	Yes
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.8.1 Open question

2.8.1) Was the origin of the fire determined?		
Question	Company	Result
		Answer
If yes, please state some details here:	EMP001 (Switzerland)	Generator circuit breaker was did not operate correctly. Generator remained connected to grid and excitation was turned off. The machine was operating in inadmissible asynchronous mode.
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Short-circuits, earth faults
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Origin in overloaded soft-soldered winding connections.
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.8.2 Check-box

2.8) Has any of the hydro generators you manufactured suffered a fire accident?		
Question	Company	Result
		Answer
2.8.2) Was the generator equipped with fire protection system?	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco

	EMP004 (Norway)	No
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Yes
	EMP046 (Austria)	Yes
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.8.2 Open question

2.8.2) Was the generator equipped with fire protection system?		
Question	Company	Result
		Answer
If yes, please state which type here (CO ² , water-spray, etc.):	EMP001 (Switzerland)	CO2
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	N.A
	EMP046 (Austria)	CO2
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.8.2.1 Check-box

2.8.2) Was the generator equipped with fire protection system?		
Question	Company	Result
		Answer
2.8.2.1) Do you know if it did work properly?	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	No
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Yes
	EMP046 (Austria)	No
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.8.2.1 Open question

2.8.2.1) Do you know if it did work properly?		
Question	Company	Result
		Answer
If yes, please state some details here:	EMP001 (Switzerland)	The system worked properly. However the cause of the fire was not eliminated. After some time, the CO ₂ had vanished and the generator restarted to burn.
	EMP002 (Brazil)	Em Branco

	EMP003 (France)	Em Branco
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	N.A
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.8.3 Open question

2.8) Has any of the hydro generators you manufactured suffered a fire accident?		
Question	Company	Result
		Answer
2.8.3) Do you have any specific comment and/or information about the damages that occurred?	EMP001 (Switzerland)	Further equipment in the power station got damaged.
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Fire extinguishes when electrical fault is disconnected, however, lots of smoke, and power station must be evacuated for a long time
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	N.A
	EMP046 (Austria)	We have discontinued the use soft soldered connections about 15 years ago.
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)

E 2.8.4 Check-box

2.8) Has any of the hydro generators you manufactured suffered a fire accident?		
Question	Company	Result
		Answer
2.8.4) Would you like to state a general recommendation considering generator fire protection?	EMP001 (Switzerland)	No
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	No
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	No
	EMP046 (Austria)	Yes
	EMP050 (Canada)	Yes

[\[Back to Question\]](#)

E 2.8.4 Open question

2.8.4) Would you like to state a general recommendation considering generator fire protection?

Question	Company	Result
		Answer
If yes, please state it here:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Clean conditions, state of the art insulation material, a proper ventilation system, brazed winding connections are essential for safe operation. Fire protection is recommended for old generators (old insulation systems, soft soldered connections, etc.)
	EMP050 (Canada)	Fire extinguishing is not required. Are recommended: fire detection, fire resistant doors.

[\[Back to Question\]](#)

E 2.9 Check-box

Question	Company	Result
		Answer
2.9) Besides the design and production of new generators, does your company participate in the refurbishment and/or maintenance area?	EMP021 (China)	Em Branco
	EMP001 (Switzerland)	Yes
	EMP002 (Brazil)	Yes
	EMP003 (France)	Yes
	EMP004 (Norway)	Yes
	EMP057 (United States)	Yes
	EMP034 (Japan)	Yes
	EMP044 (Japan)	Yes
	EMP046 (Austria)	Yes
	EMP050 (Canada)	Yes

[\[Back to Question\]](#)

E 2.9 Open question

2.9) Besides the design and production of new generators, does your company participate in the refurbishment and/or maintenance area?		
Question	Company	Result
		Answer
If yes, please state some details here:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Main activity is service and refurbishment
	EMP057 (United States)	rewind and stator and rotor replacement
	EMP057 (United States)	
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Rehabilitation of existing generator
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	We are active in refurbishment/modernization world wide.

	EMP050 (Canada)	From rewinding to complete stator replacement and rotor work.
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[\[Back to Question\]](#)

E 2.9.1 Check-box

2.9) Besides the design and production of new generators, does your company participate in the refurbishment and/or maintenance area?		
Question	Company	Result
		Answer
2.9.1) If yes, does it include the fire extinguishing systems?	EMP021 (China)	Em Branco
	EMP001 (Switzerland)	No
	EMP002 (Brazil)	Yes
	EMP003 (France)	Yes
	EMP004 (Norway)	No
	EMP057 (United States)	No
	EMP034 (Japan)	Yes
	EMP044 (Japan)	No
	EMP046 (Austria)	No
	EMP050 (Canada)	Yes

[\[Back to Question\]](#)

E 2.9.1 Open question

2.9.1) If yes, does it include the fire extinguishing systems?		
Question	Company	Result
		Answer
If yes, please state some details here:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	REPLACE
	EMP003 (France)	Generally the fire protection system is already installed in the power station, sometimes we are asked to refurbish it.
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Replacement of existing fire extinguishing system
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Sometimes in major rehabs

[\[Back to Question\]](#)

E 2.10 Check-box

Question	Company	Result
		Answer
2.10) According to your opinion, is there any question that is missing in this part of the questionnaire?	EMP001 (Switzerland)	No
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	No
	EMP004 (Norway)	No
	EMP057 (United States)	No
	EMP021 (China)	Em Branco
	EMP034 (Japan)	No

	EMP044 (Japan)	No
	EMP046 (Austria)	No
	EMP050 (Canada)	No

[\[Back to Question\]](#)

E 2.10 Open question

2.10) 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:	EMP001 (Switzerland)	Em Branco
	EMP002 (Brazil)	Em Branco
	EMP003 (France)	Em Branco
	EMP004 (Norway)	Em Branco
	EMP057 (United States)	Em Branco
	EMP021 (China)	Em Branco
	EMP034 (Japan)	Em Branco
	EMP044 (Japan)	Em Branco
	EMP046 (Austria)	Em Branco
	EMP050 (Canada)	Em Branco

[\[Back to Question\]](#)