
Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

17 November 2021

Sub-Committee of Experts on the Transport of Dangerous Goods

Fifty-ninth session

Geneva, 29 November-8 December 2021

Item 5 (c) of the provisional agenda

Transport of gases: miscellaneous

Report of the intersessional working group on the pV-product limit for pressure receptacles

Submitted by Chair of the informal working group

1. The working group met under the chairmanship of Dr Georg W. Mair (Germany) for a third time on 25th October 2021 from 1 to 5 p.m. Geneva time (CET). Delegates from Belgium, China, Germany, Sweden, United Kingdom (UK), United States of America (USA), CGA, ECMA, EIGA and ISO joined the meeting. The delegation from Germany provided the secretary.
2. The working group considered during the meeting the following documents: ST/SG/AC.10/C.3/2020/18 with related informal documents INF 52 (ECMA) and INF 53 (Germany), the last report of the intersessional working group on the pV-product limit for pressure receptacles informal document INF.38 (58th session) and the reports of the Sub-Committee of Experts on the Transport of Dangerous Goods ST/SG/AC.10/C.3/114 and ST/SG/AC.10/C.3/116.
3. For the meeting the Chair drafted an agenda that was confirmed by the participants. This agenda addressed the parts mentioned in the following items in the order of discussion. This online meeting was guided by the usage of a prepared set of slides that are appended to this report.
4. ECMA drew the attention of the working group to the terms of reference. They addressed the matter of salvage pressure receptacles for pressure receptacles which are defined in the Model Regulation with a water capacity of not more than 3000 litres. The Chair considered the initial proposals from ST/SG/AC.10/C.3/2020/18 and expressed the importance of a pV-product for the handling of salvage pressure receptacles and the subsequent recognition of this item for safe and free transport of gases in general.
5. Introducing the topic, the Chair presented parts of the last report of the Sub-Committee of Experts and the report of the intersessional working group on the 1st and 2nd meeting on the pV-product limit for pressure receptacles. A “red line”, to limit a worst-case consequence for pressure receptacles, at 30 fatalities or 450 injured persons had been discussed in the 2nd meeting. These values were confirmed by the working group as criteria for the evaluation of the relevant pV-value. These values were considered as benchmark values as such values are likely to vary from country to country.
6. The Chair summarised the discussion of the 2nd meeting on the population density. The latest agreed value was 6000 pers./km². The Chair asked the participants whether new aspects had arisen since the last meeting or whether the value of 6000 pers./km² could be confirmed as reference for the population density. China, UK and USA remarked that one single value does not reflect the distribution of the population density very well. There is a high variation between rural areas, some cities and the centres of mega-cities. Critical are especially districts in inner cities with highways to port areas. Consequently, it is difficult to find a reference value. Finally, Belgium, China, Germany, Sweden, UK, USA confirmed a

reference value of 6000 pers./km² for the population density is appropriate for the estimation of consequence sizes in generalized scenarios.

7. The Chair asked the participants if there are specific needs or requests for changing the initially proposed test pressure volume product of 1.5 million bar litres. ECMA could not have an internal discussion but will address this topic on the next ECMA-meeting in November 2021. Furthermore, ECMA stated that pressure receptacles with a test pressure of 1500 bar are needed for ground storage at hydrogen fuelling stations and CGA added that 1.5 million bar litres (and larger) with at least 1000 bars are common for fuelling stations and must get transported. Germany pointed out that the transport of stationary equipment under pressure is not accepted and stationary applications fall under different rules. If necessary, it may be helpful to look for a special provision as it is available for the transport under pressure of onboard storage systems. China reminded the working group to focus on the transport of dangerous goods. CGA explained that transport containments with a higher pV-product and a higher volume than 3000 litres are on the road in North America. Once again ECMA pointed out to focus on pressure receptacles, which are limited to a water capacity of not more than 3000 litres in the UN Model Regulations. Delegates from the USA clarified that the scope of the discussion includes pressure receptacle and salvage pressure receptacle. The current limit for DOT cylinders is significantly less than 1.5 million bar litres and high pV-product containments are transported under special permits, exclusively. High pV-product containments under special permits must fulfil special requirements and undergo tests in addition to standards referenced in the Model Regulations or required for DOT cylinders. For pressure receptacles conforming to the Model Regulations, CGA considered 1.5 million bar litres as suitable for the pressure receptacles being in service today but noted a trend to higher test pressure volume products than 1.5 million bar litres. Pressure receptacles up to 1200 bar test pressure and 3000 litres volume (3.6 million bar litres test pressure volume product) are reasonable for CGA. UK proposed to study the consequences for different values of the test pressure volume product, which would be beneficial for further discussions with their national experts under consultation of experts from other areas. The working group agreed on a comparison of consequences caused by hydrogen tubes with test pressure volume products of 1.5 million bar litres, 2 million bar litres, and 3.6 million bar litres.

8. For the discussion on the scope including pressure receptacle and salvage pressure receptacle paragraph 6.2.3.5 of the UN Model Regulations “Salvage pressure receptacles” was read carefully. The chair of the relevant Working Group of the UN Sub-Committee explained that, as no design code is mandatory, the variety of salvage pressure receptacles is too wide for elaborating a design and test standard. EIGA indicated that currently there are no problems in the usage of salvage pressure receptacles. Referring to the provisions “Instructions on the safe handling and use of the salvage pressure receptacle shall be clearly shown in the documentation for the application to the competent authority and shall form part of the approval certificate.” in paragraph 6.2.3.5, the working group recognized that the limitation of the test pressure volume product for pressure receptacles is beneficial for the safe use of salvage pressure receptacles.

9. German representatives re-calculated and presented the consequence sizes of a pressure receptacle rupture at test pressure volume products of 1.5 million bar litres, 2 million bar litres, and 3.6 million bar litres for hydrogen. UK delegates confirmed that hydrogen as a “reference gas” is appropriate because the transported quantities will be high and a challenge in future. For a test pressure volume product of 1.5 million bar litres the consequences in most scenarios are below the assumed “red line”. Consequences in many scenarios are beyond the assumed “red line” for a test pressure volume product of 3.6 million bar litres.

10. The Chair drew attention to the original task discussing proposals 1 and 2 of document ST/SG/AC.10/C.3/2020/18 and submitting a new proposal. Proposal 1 contains the introduction of the test pressure volume product limit for pressure receptacles and proposal 2 contains the limitation of the capacity for salvage pressure receptacles. Both proposals address the safe use of salvage pressure receptacles.

11. At the end of the meeting the Chair gave a summary of the situation, which cannot be solved easily. Pressure receptacles being in service seem to have a test pressure volume product of less than 1.5 million bar litres and therefore fulfil the assumed “red line” to limit

a worst-case consequence. Pressure receptacles with a test pressure volume product of more than 1.5 million bar litres may be marketed within the next years. In preparation of the next meeting all participants are asked to consider an appropriate test pressure volume product with regards to avoiding a catastrophic consequence.

12. The working group is interested in continuing its work and in finding a proposal for a pV-limit and recognizes the meaning for the capacity of salvage pressure receptacles. Therefore, the working group seeks the consent of the Sub-Committee to continue this work.

Sicherheit in Technik und Chemie

October 25th, 2021

3RD MEETING

TDG - INTERSESSIONAL WG on pV-PRODUCT

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Agenda (drafted)

- supported with a presentation

Start at about 13:00 CEST

- Top 1: Agenda, attendance and a short introduction round**
- Top 2: Outcome of 58th UN-SubCom ETDG**
- Top 3: Summary of the last meeting**
- Top 4: Discussion on the reference value for the population density**
- Top 5: Determination of the appropriate pV-value (continued after the break)**

Break at about 15:00

- Top 6: Proposal to introduce the pV-value**

End at about 17:00

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Top 2: Outcome 58th UN-SubCom ETDG

October 25th, 21 UN-TDG: Intersessional WG on the limitation of the pV-product

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Outcome of 58th UN-SubCom ETDG



UN-SubCom ETDG – WG „pV-Limit” Report of the Sub-Committee of Experts on the Transport of Dangerous Goods on its fifty-eighth session held in Geneva from 28 June to 2 July 2021

Report ST/SG/AC.10/C.3/116

60. The Sub-Committee welcomed the outcome of the intersessional working group on the pV-product limit for pressure receptacles and encouraged the group to continue its work. It was clarified that the group's discussions on the level of risk assessment was linked to the specific risks of pressure receptacles only and not to a general type of risk.

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Top 3: Summary of the last meeting

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Results of last discussion

Report UN-SCETDG-58-INF38 para. 16

"In summary, representatives of Belgium, Germany, Sweden, UK, USA, CGA, ECMA, EIGA and ISO, recommended **to work for the "red line" and introduce a pV-value to limit worst case consequences for pressure receptacles.**

All of them are limited to a water capacity of not more than 3000 litres. This led back to the initial intention of improving the definition and usage of salvage pressure receptacles. Germany proposed in its initial document that just the salvage pressure receptacle should not be limited by water capacity. These should be limited by the maximum pV-product, only."

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Limitation of "consequence size"



Report UN-SCETDG-58-INF38 para. 13 and 16

"China stated that a value of 45 fatalities in line with Swiss regulation would be too high. According to their regulations, 30 fatalities is the borderline from a major accident to a catastrophe, so they would prefer the maximum acceptable consequence to be determined as 30 fatalities, instead of 45 ([...])."

"The chair asked all participants to check if there are additional arguments that should be considered in the discussion on the pV-product with respect to the sudden failure of a pressure receptacle with a water capacity of not more than 3000 litres. So far, based on the shown analysis a value of 1,5 Mio bar litre seems to be reasonable in the context of criteria like a population density of 6000 pers./km² and **consequence limits of 30 fatalities or 450 injured persons.**"

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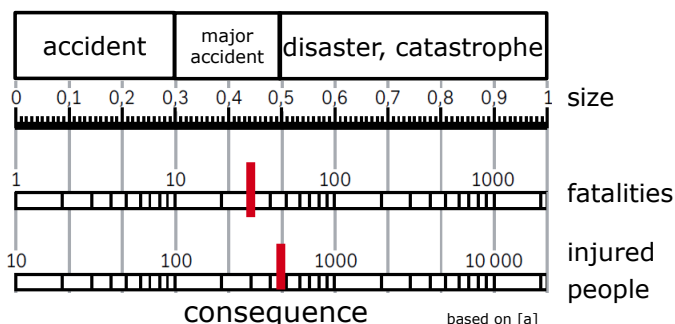
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Limitation of "consequence size"



Display of the agreed "red line"



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Top 4: Discussion on the reference value for the population density

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Results of last discussion

Report UN-SCETDG-58-INF38 para. 16

"The chair asked all participants to check if there are additional arguments that should be considered in the discussion on the pV-product with respect to the sudden failure of a pressure receptacle with a water capacity of not more than 3000 litres. So far, based on the shown analysis a value of 1,5 Mio bar litre seems to be reasonable in the context of criteria like a **population density of 6000 pers./km²** and consequence limits of 30 fatalities or 450 injured persons."

After some weeks of consideration:

Do all members confirm a reference value of 6000 pers./km² for the population density as proposed by SWE and BEL?

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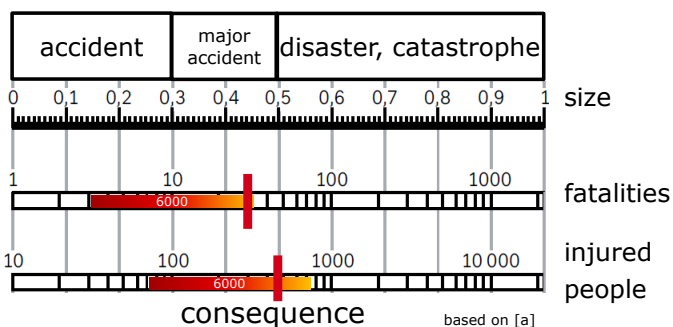
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Quantification of "consequence size" for H₂



Estimation for
 pV-product = **1.5 million bar litres**
 and population density of
6000 people/km²



6000 people/km²:

3 to 33 fatalities
 $size_{6000} = 0.15 \text{ to } 0.46$

71 to 736 injured people
 $size_{6000} = 0.26 \text{ to } 0.55$

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Top 5: Determination of the appropriate pV-value

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Results of last discussion



Report UN-SCETDG-58-INF38 para. 16

“ECMA and EIGA will discuss some aspects tackled in this meeting with their experts and will provide their official position later.”

After some weeks of consideration:

Do members have specific needs/requests for changing the proposed test pressure volume product of 1.5 million bar litres?

October 25th, 21 UN-TDG: Intersessional WG on the limitation of the pV-product

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Approach for the final assessment



Parameters discussed

max. consequence size (determined) : 30 fatalities or 450 injured people
 population density (by member states) : 6000 people/km²
 pV-product asked by industry : 1.5 million bar litres

Visualisation of the final outcome

1. Estimation of pressure wave for a given test pressure volume product for H₂
2. Estimation of radii for fatalities and injured people
3. Estimation of numbers for fatalities and injured people
4. Comparison of estimated consequence with accepted consequence size

- **Break for preparation**
- **Result of analysis after the break**

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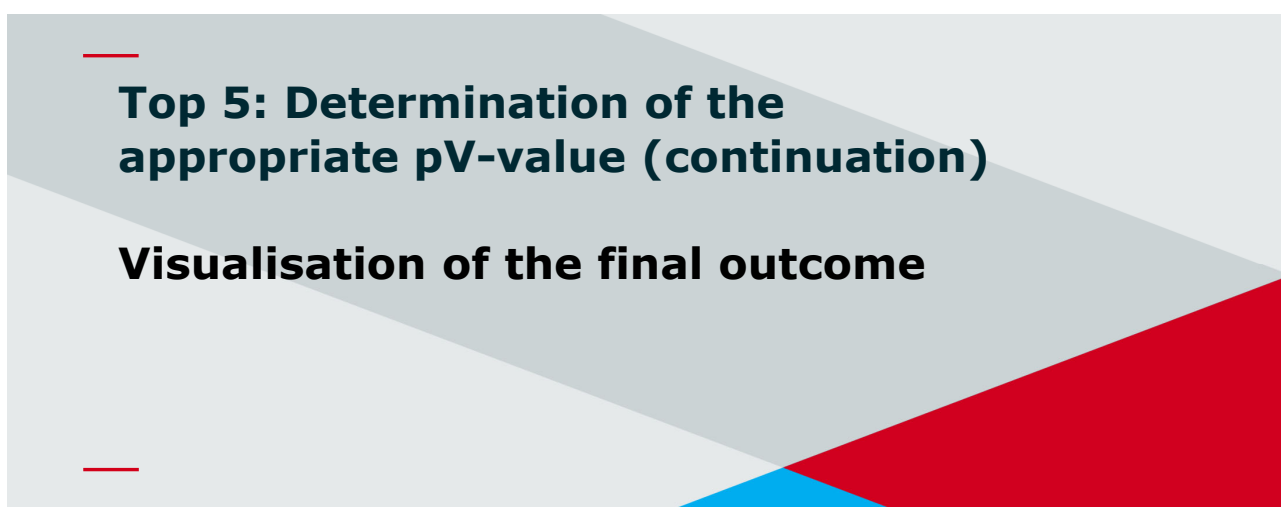
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Visualisation of the final outcome



Parameters discussed

- max. consequence size (determined) : 30 fatalities or 450 injured people
- population density (by member states) : 6000 people/km²
- pV-product asked by industry : 1.5 million bar litres

Visualisation of the final outcome

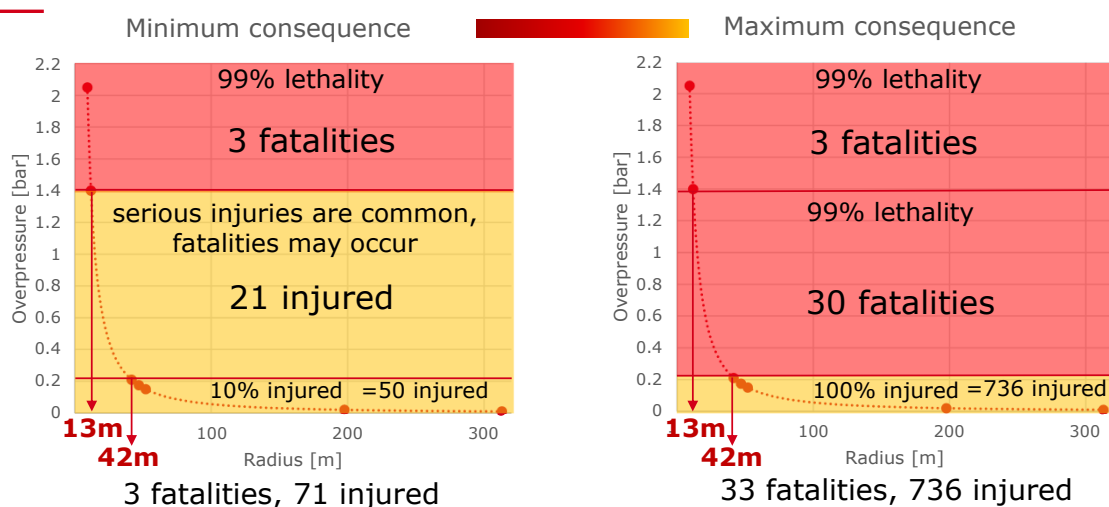
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4. Comparison of estimated consequence with accepted consequence size

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Estimation of radii for fatalities and injured people



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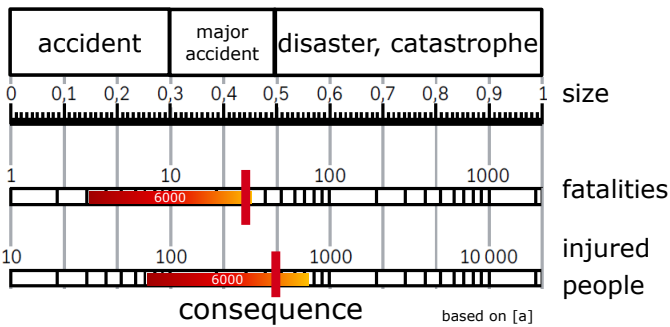
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Quantification of "consequence size" for H₂



Estimation for
 pV-product = **1.5 million bar litres**
 and population density of
6000 people/km²



6000 people/km²:

3 to 33 fatalities
 size₆₀₀₀ = 0.15 to 0.46

71 to 736 injured people
 size₆₀₀₀ = 0.26 to 0.55

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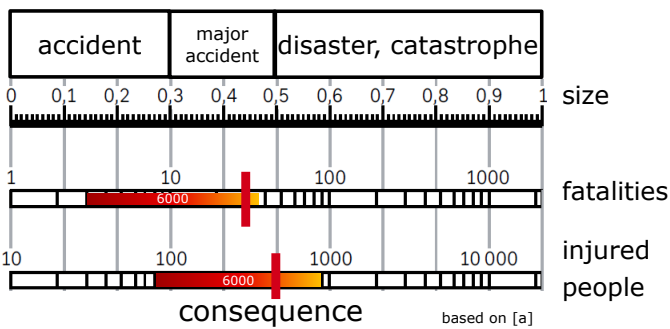
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Quantification of "consequence size" for H₂



Estimation for
 pV-product = **2.0 million bar litres**
 and population density of
6000 people/km²



6000 people/km²:

3 to 38 fatalities
 size₆₀₀₀ = 0.15 to 0.48

85 to 889 injured people
 size₆₀₀₀ = 0.28 to 0.59

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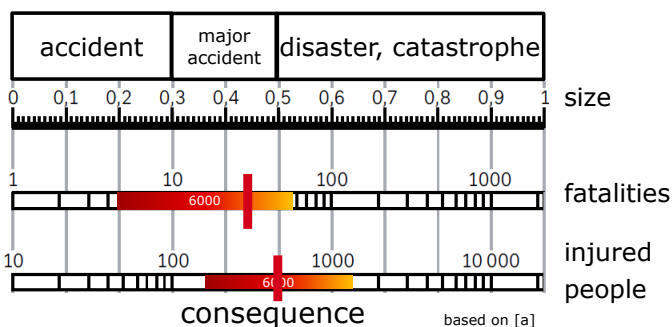
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Quantification of "consequence size" for H₂



Estimation for
 pV-product = **3.6 million bar litres**
 and population density of
6000 people/km²



6000 people/km²:

4 to 56 fatalities
 $size_{6000} = 0.19 \text{ to } 0.53$

177 to 1300 injured people
 $size_{6000} = 0.38 \text{ to } 0.64$

October 25th, 21 UN-TDG: Intersessional WG on the limitation of the pV-product

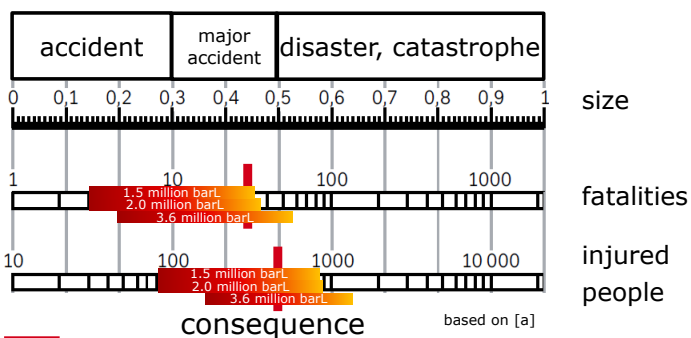
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Quantification of "consequence size" for H₂



Estimation for
 pV-products = **1.5, 2.0 and 3.6 million bar litres**
 and population density of
6000 people/km²



1.5 million barL: 3 to 33 fatalities $size_{1.5\text{MiobarL}} = 0.15 \text{ to } 0.46$ 71 to 736 injured people $size_{1.5\text{MiobarL}} = 0.26 \text{ to } 0.55$
2.0 million barL: 3 to 38 fatalities $size_{2.0\text{MiobarL}} = 0.15 \text{ to } 0.48$ 85 to 889 injured people $size_{2.0\text{MiobarL}} = 0.28 \text{ to } 0.59$
3.6 million barL: 4 to 56 fatalities $size_{3.6\text{MiobarL}} = 0.19 \text{ to } 0.53$ 177 to 1300 injured people $size_{3.6\text{MiobarL}} = 0.38 \text{ to } 0.64$

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Outcome



A test pressure volume product for pressure receptacles not exceeding **1.5 million** bar litres is appropriate to presumably avoid a catastrophic consequence.

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Top 6: Proposal to introduce a pV-value

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The task



Report ST/SG/AC.10/C.3/114 says:

Modifications concerning salvage pressure receptacles

Document: ST/SG/AC.10/C.3/2020/18 (Germany)

Informal documents: INF.52 (ECMA) INF.53 (Germany)

35. Following the comments received during the informal session on informal documents INF.52 and INF.53, the Sub-Committee adopted the amendments under proposal 3 in ST/SG/AC.10/C.3/2020/18 (see annex I). It was agreed to set up an intersessional working group led by Germany to further discuss proposals 1 and 2, and to submit a new proposal for consideration during the next biennium.

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Proposal to introduce a pV-value



Based on ST-SG-AC10-C3-2020-18 (Proposal 1)

1.2.1

Pressure receptacle means a transportable receptacle intended for holding substances under pressure including its closure(s) and other service equipment and is a collective term that includes cylinders, tubes, pressure drums, closed cryogenic receptacles, metal hydride storage systems, bundles of cylinders and salvage pressure receptacles with a test pressure volume product not exceeding 1.5 million bar litres;

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pV-product proposal



As in ST-SG-AC10-C3-2020-18 (Proposal 2)

1.2.1

Salvage pressure receptacle means a pressure receptacle ~~with a water capacity not exceeding 3 000 litres~~ into which are placed damaged, defective, leaking or non-conforming pressure receptacle(s) for the purpose of transport e.g. for recovery or disposal;

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Thank you for your contribution

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