QUESTIONS ABOUT PURPLE BOOK FROM CATALONIAN INDUSTRIAL SAFETY DIRECTORATE

A. Screening

1. The screening phase of the QRA included in PB indicates that a LOC could be excluded only if one condition is fulfilled: its frequency is lower than 10^{-8} per year or its lethal damage (1 % probability) doesn't exceed the plant boundary. After the event trees the LOC is divided in final accidents. Is the criterion still applicable at this final level?
   The condition that a LOC can be excluded if the frequency is less than 10^{-8} per year is applicable to the combination of LOC (e.g. line rupture) and system reactions (e.g. failure of the closing of valves 0.01 per demand).It is not applicable to the further division in e.g. weather class, wind direction, effects (like direct/indirect ignition, BLEVE).

2. Some substances are solutions of products in such a way that the solution is not classified as dangerous although they can emit vapours of classified substances. This is the case of ammonia solutions or HF solutions. Would you consider them in the QRA?
   Some HF solutions are classified as toxic (> 30% HF in water) and should be taken into account. I think we assume that, if the solution is not classified as toxic (< 30% HF in water), the amount of vapour emitted is too low to cause lethal effects outside the plant boundary, and therefore is usually not considered in the QRA for external safety. However, if you are aware of a situation where for such solutions an externals safety case exists, I am interested to know. I think it should then be considered in the QRA.

3. We would like to use the criteria of LC1 (of the worst generic LOC or specific scenario) as an alternative to the screening method described in PB. Would it be acceptable?
   Yes, that would be acceptable. I assume you then use an absolute criterion and not a relative one, and include all installations having an external effect (LC1 outside the plant boundary). Correct?

4. In the screening method described in PB the criteria for eliminating an area is that the index is higher than 1 and higher than the medium value of indexes. Does it mean that the criterion is not an absolute one but a comparative one?
   The screening method is intended for selecting the most dangerous installations. The criterion is indeed a comparative one: installations are selected if at a location the selection number is higher than 50% of the maximum selection number at that location (I am not sure what you mean by medium value; it is not the median value). In our review of the selection method, we have now added a few criteria:
   1. the screening method may only be applied if at least five installations are present;
   2. at least five installations are selected for the QRA
   3. for each location on the site boundary, at least three installations with Selection number larger than one are selected before the 50% rule is applied.

5. How should the screening be applied when the distance from the fence to the selected equipment is less than 100 m?
   The screening methodology has problems if the installation is close to the site boundary, i.e. shorter than 100 meters. I think we should always keep in mind that it is only a rough screening method, which should not be applied rigorously.

The basis of the value of 100 meters is twofold: (1) the selection number of one installation would get too much weight if the distance is considerably less than 100 meters and (2) the limit value is based on (lethal) effects at distances in the order of 100 meters.
I think that in case the installation is very close to the site boundary, you should consider not to rely too much on the selection method, but to include also the installations in the QRA which are likely to give a risk due to their very short distance.
It should be noted that in the review of our screening method, a number of additions are introduced:
- now at least five installations should be considered in the QRA, even if all selection numbers are less than one
- at each position on the site boundary, at least three installations with selection number larger than one should be selected.
The reason for these additions are, that the selection method is intended for large sites only, and is sometimes misused for small sites trying to avoid to make a QRA. We do, however, always allow companies to exclude installations if, based on effect distances, it is demonstrated that there are no effects outside the site boundary.

B. Selection of scenarios/frequencies

1. PB gives the catastrophic rupture of road/wagons tankers frequencies in a year reference while rupture of loading arm/flexible are hour referenced. Is it possible to use an utilization factor for the catastrophic rupture: that is consider that the data (catastrophic rupture of tankers frequency) is given for 8760 hours per year and take into account the time presence of the tanker in the plant?
   Yes, you should modify the frequency of catastrophic rupture for the time presence of the tanker: if a tanker is only present 40 hours per year, than the frequency of catastrophic rupture is equal to 40/8760 x 5e-7 (pressurized).

2. What is considered to be an atmospheric tank? And a pressurized tank?
   The Pressure Equipment Directive is followed: when the Maximum allowable pressure (means the maximum pressure for which the equipment is designed, as specified by the manufacturer) is larger than 0.5 bar gauge, it is considered as a pressurized tank.

3. What is considered to be an atmospheric road tanker? And a pressurized road tanker?
   I have not a good definition yet.

4. If the road/wagon tanker is a pressured one, would it be possible to take the frequency of pressure tank if it transports an atmospheric product?
   We consider the strength of the tanker to be important to the failure frequency, not the product in it. So if the tanker is designed as a pressurized tank, the frequencies for pressurized tankers should be applied.

5. In our perspective the fire under a tank/tanker can conduce, depending on the characteristics of the product, to a BLEVE, which will begin by a rupture of the wall and will conduce finally to the rupture of the tank. The phenomenon will be accompanied by overpressure, fragments projection and thermal radiation of the fireball, if the product is flammable. The BLEVE, which is mentioned in the PB, is one of the final accidents associated to a

catastrophic rupture of a tank/tanker. It is also described in this way in the questions/answers (July 2003). Does it mean that PB is speaking there of the fire ball exclusively? How and where is the "complete BLEVE" included in PB? Additionally due to the PB treatment the final probability of a BLEVE is low if compared with the English FRED.
Indeed, a fire under the tank will result in a BLEVE. The BLEVE phenomenon consists of overpressure, fragments and thermal radiation of the fireball, which all occur simultaneously. The dominant effect is the heat radiation of the fireball, as shown in Figure 5.A.2, where overpressure effects are compared with heat radiation. The lethality due to fragments is expected to be lower. We therefore describe all the effects of the BLEVE with the heat radiation of the fireball.

6. For cryogenic installations of natural gas, would you use the frequencies given for catastrophic rupture or would you consider lower values?
   We would use the frequencies for the atmospheric tank that are applicable, so presumably the full containment tank.

7. Page 4.5 of PB shouldn't be 0,1 per demand the last point (a hand operated blocking system).
   In fact, it is in this case not important, since the total reaction time is equal to 30 minutes, which is the maximum outflow duration assumed. We now have added the possibility for the intervention of an operator standing next to an unloading operation (no automatic detection). In that case, we indeed prescribe a probability of 0.1 per demand.

8. From the questions/ answers to authors of PB (July 2003) it appears that a buried GLP tank will have exactly the same LOC as air open tank, except the scenario of BLEVE Is it correct?
   That is correct. Actually, it is the way the frequency for a buried tank is derived, namely by assuming that the BLEVE part of the event tree does not occur.

9. PB suggests to determine the probability of failure on demand of a repression system with tools like fault tree analysis (page 4.6) or to use as a default value of 0,05 per demand. By means of which criteria would you determine if the system should or not be taken into account and verify its efficiency. For example which design criteria would you require to reduce a 50% of the emission of chlorine gas would you consider for a G1/G2/G3 scenario?
   This is complicated. The operator should demonstrate whether a repression system, like a water curtain is efficient and under what conditions. You should then evaluate whether the case is strong enough to accept.

10. The probability of delayed ignition is mentioned in page 4.15 and developed in appendix 4.A page 4.19. The method is quite complicated to apply in a practical QRA. Is it possible to use some kind of simplification? For example to assume that the probability of delayed ignition is one?
    The procedure described using actual ignition sources applies to Societal Risk. Of course you may assume for the Societal Risk also that the probability of delayed ignition is one. The way the Individual Risk (now called Location specific risk) is calculated is by assuming that always delayed ignition occurs at largest cloud area; this gives a (small) overestimation of the risk compared to reality. You may decide to apply the same overestimation also to Societal Risk. The procedure described is applied in the model to be used in the Netherlands.

C. Consequences determination

1. The LOC "discharge of a PSV", has to be modeled at the set point pressure of the PSV? If not, at what pressure?
   Yes, the set point pressure is correct. By the way, we do not expect any dangerous effects from the pressure relief valve, because the design of an installation should be in such a way that any foreseeable event, like opening of a PRV, will not result in any (lethal) consequences. This is often prescribed in permits.

D. Special cases:

1. According to the CPR18E PROBIT toxicity constants, we have noticed some problems using the PROBIT toxicity values. We have compared the concentration value according to LC1% (considered as lethality threshold), with some toxicity levels referred to non lethality effects (like IDLH, AEGL, TEEL, etc).Applying this analysis to CPR18E PROBIT constants list, we have identified up to seven cases where the LC1% gives a concentration lower than these toxicity levels. LC1% should have higher concentrations, because it's referred to worse effects, so, in these seven cases, we doubt about PROBITs validity. Is there any error in these PROBIT constants? Is it correct to use them? To explain this situation we give the next figure where toxicity values and PROBIT equations are compared for Ethylene Oxide. Please notice that IDLH, AEGL-3, and ERPG-3 are referred to concentration values between LC1% and LC50%.
   Most probit values given in the Purple Book go back to about 10 – 20 years ago and were derived from animal data. In this process, a selection is made of the relevant animal data and various extrapolations are done, e.g. from 4 – 8 hours exposure to short term exposure and from animal to human. In this process, safety factors are applied. This resulted in the list of probit constants as given in the PB.
   However, there is a lot of uncertainty associated with the probit constants due to extrapolations. As you pointed out correctly, you would expect the LC1% value to be higher than the ERPG values. These differences might be caused by e.g. a re-evaluation of the original toxicity data using different animal studies, and using less conservative extrapolation factors. There is no error in the printing of the probit values. Whether you consider the probit values being acceptable for a QRA calculation, or whether you want to re-evaluate the probit functions and derive a new function based on (new) toxicity data is your decision.

2. For storage installation there is in point 3.2.7 reference to CPR 15 which is not available in English. Do you know if there will be a translation of the document?
   A translation of the text is attached.

3. For aerosols (storage of small units with small quantities of GLP –grams-) in each ones) that are not mentioned in PB which treatment would you recommend?
   In general, we consider the storage of small units with small quantities of e.g. propane, like spray cans, not relevant to external safety.