THE FSG-10 ISSUES

I don't feel that our Nuclear community **is aware enough of the threat of the nitrogen inside the pipes** and of the difficulty of isolating or venting the accumulators during the ELAP accident.

The nitrogen greatly affects the heat transfer and the proper operation of the cooling systems. In the three (or four) passive accumulators usually installed in our plants, there is enough nitrogen to fill all the RCS volume (of course, depending on the RCS pressure/temperature).

Reviewing the FSG-10 Emergency Guide written by the PWROG and some derived guides from the plants; I found some significant challenges to doing a proper implementation. It appears that these guides are not still developed enough, neither at the PWROG, nor at the plants, and the difficulties of implementing this guide seem not fully considered or even underestimated.

The FSG-10 guide gives very short directions to isolate or vent the accumulators, leaving to the plants the specific details to proceed with. It appears that it underestimates the real work that must be done to achieve this goal.

This work is more challenging and "blind" than it is expected for several reasons:

- The developing work done by the plants to accommodate this guide to their specific designs and configuration is **still weak and without the proper detail** to be properly done. All that I have read does not include many details about how the work must be done. It seems to rely on the operator's ability **to improvise the best way to do it!**

  As an example, in these guides is not properly described the way how the power from FLEX generators has to be routed and connected to the isolation valves circuitry. If any provision of alternative paths has been done, (with a design modification), it could be difficult (or even impossible) to route this cabling across locked (and dark) rooms to reach all the valve's circuitry. All of these valves are 3-phase powered, and it's crucial to meet the correct phase rotation to operate the valves.

- I should review each specific case to do a correct response, but it seems that the only modifications done by the plants to be adapted to the FLEX equipment are the specific ones to allow the hydraulic connections to the existing systems, and some electrical connections to the main emergency systems. **Most haven't done any modifications to help with the FSG-10 guide specifically**.

- The FSG-10 relies in the FLEX equipment, the operators work and in the proper operation of the installed elements (mainly the isolation valves and their circuitry). It also needs that some instrumentation is available to determine when the isolation has to be done. **All of these elements have**

to work properly to achieve the goal. This means that if only one of these elements fails, then the whole procedure fails.

As an example, ALL the electrical components of the valve actuator must work properly (electrical protections, cabling, AC motor, limit switches, torque limiters, gear mechanisms...). We must remember that the ambient in the containment building will be harsh in these situations, and if only one of these elements fails, it's enough to ruin ALL the strategy.

- Usually operators haven't a wide range accumulator level (only a narrow range. Even if available, this equipment usually isn't Class 1E designed. And their indication can be very dependent on the ambient temperature in the accumulators. Then, it could be very difficult to know the real level inside the accumulators and to determine when this strategy have to be started.

- In the same way, it could be difficult (or even impossible) to know whether the operation has been successful or not. If the closing order is not being fully completed, sooner or later **this nitrogen will reach the RCS** across the -not perfectly closed- isolation valve. And operators only will realize when the level or pressure inside accumulators still continues their slow drop… But, although they can be aware of it after some time, **they can't do anything more to fix it!**

- Due to the high boron concentration inside the accumulator, the instrumentation in the accumulators is connected to the process using sealed capillaries. This sealed capillary <u>is very affected by the temperature</u>, due to its inner fluid dilatation. It can lead to a very imprecise measurement of the accumulator level. During the ELAP accident, and the subsequent LOCA, the temperature will rise in the containment building, and also will be stratification that will disturb the measurements.

- Even with all the instrumentation working properly, it’s difficult to find the correct moment (unless a wide range level of accumulators is available). There are many variables that must be taken into account, such as the ambient temperature in the area of accumulators. The correct moment to perform the isolation must be determined considering which the priority is: to maximize the water injection or avoid nitrogen injection. If the isolation/venting is done too soon, its injection capabilities will be lost. If it’s done too late, some nitrogen will get into the system.

- But the most annoying situation is that this actuation **must be done <u>in all the</u> accumulators of the system <u>at the same time</u>**. This requires a lot of coordination. There is a lot of work for the operators, and without guarantees of being succeeded. If just one accumulator fails to be properly isolated, then the nitrogen will reach the system.

- If we choose venting, the problems to achieve it could be even more. The air-operated valves, usually used to vent, cannot actuate because they need not only some AC power (electrovalves), **but also enough air pressure and their air piping lines available** to allow it. All of these valves are

designed to remain closed by default, and then they require the constant open order and energy to fulfill the operation. On the contrary…if this actuation can be done, then the operators can know if the operation has been successful and with guarantees. That is because, even with miscalibrated instrumentation, the fast pressure drops can be seen, and this fact can guarantee that this nitrogen will not reach the system because it is being exhausted to the containment atmosphere.

- But the main problem to this strategy is that air pipes in containment are not safety related. So, we can't rely on them.

I'm still surprised that the NRC staff is not still aware of these challenges. It will, probably soon, require us to develop alternative and more guaranteed ways to avoid the nitrogen injection. We do not have to wait until these directions come from our regulator. **We must fix it before!**

From my perspective, **our nuclear community is still UNDERESTIMATING the threat of the nitrogen injection inside RCS** and, consequently, we're still not prepared to cope with it. One of the main lessons learned from Fukushima was **that if you underestimate the probabilities of the issues, then sooner or later these issues will pass over you** as the tsunami did in Fukushima over the "well-designed" anti-tsunami wall.

During the last days, I realized that some skilled earthquake experts warned TEPCO and the government of Japan of the tsunami risk many years before the accident happened. Nothing effective was done to protect the public. **In this case we're still on time!**