

*Technical Meeting on the Safety of High
Temperature Gas Cooled Reactors in the
Light of the Fukushima Daiichi Accident*

***HTGR safety CRP proposal
from China***

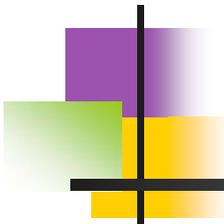
Fu LI

*INET, Tsinghua University, China
lifu@tsinghua.edu.cn*

VIC, Vienna, Austria

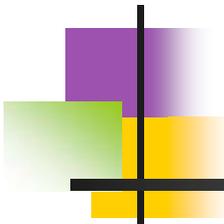
April 8-11, 2014





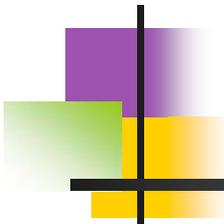
Proposals

- ***I am willing and ready to join the new CRP, based on consensus of this meeting***
 - ***To draft new safety requirement***
 - ***Even new safety design guides (criteria)?***
 - ***It will be easy if just a new safety requirement, based on the experience in China***



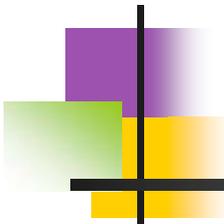
Proposals

- ***Existing contribution:***
 - ***Experience in HTR-PM design and licensing***
 - ***Design criteria of key systems and key components***
 - ***Draft document equivalent to old IAEA NS-R-1 (in 2003)***
 - ***Policy announcement for HTR-PM SAR review***



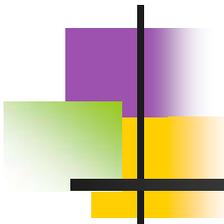
Reference information

- ***INET & Chinese NNSA developed HTGR version of NS-R-1 in 2003***
 - ***It increases the understandability of safety features of modular HTGR***
 - ***It is not directly used in licensing phase***
 - ***The requirement is based on NS-R-1 itself (equivalent to HAF102 in China)***
 - ***Detailed requirement is fixed in detailed design criteria itself***



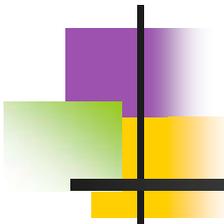
Proposals

- ***My recommendations - I***
 - ***It is better to be technology neutral for safety requirement, maybe with some interprets for some requirements for specific reactor type, as appendix, or revision***
 - ***Safety requirement and goals must be comparable with other type NPPs***
 - ***Crucial goal is the radioactive release into environment***
 - ***It is possible to draft a safety guides for modular, with reference/different design approaches***
 - ***Too much works, must be detailed***



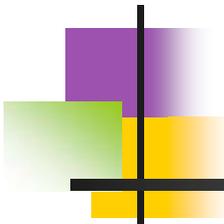
Proposals

- ***My recommendations - II***
 - ***It is recommended to refer directly to modular HTGR, instead of general HTGR***
 - ***It is better not to be so ambitious for the objective of this new CRP***
 - ***Based on current framework and requirements as much as possible***
 - ***Risk informed approach plus deterministic requirement is useful, TLRC is an example***
 - ***It is impossible to develop a new framework***



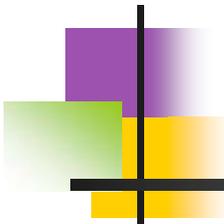
Proposals

- ***My recommendations - III***
 - ***It is better not to be so ambitious for the objective of this CRP***
 - ***Current specification for TRISO coated particle fuel is acceptable, also further improvement in fuel performance and manufacturing technology is foreseeing***



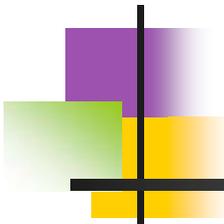
Proposals

- ***My recommendations - IV***
 - ***Following issues can be addressed***
 - ***Low susceptibility of coolant lost***
 - ***Naturally disperse of decay heat***
 - ***High performance of TRISO fuel***
 - ***Long tolerance time as additional level of barrier / Defense in Depth***
 - ***VLPC/confinement is feasible***
 - ***Emergency plan is not need technically with specific dose consequence limit***
 - ***Is it possible to define the quantitative safety goal in this CRP?***



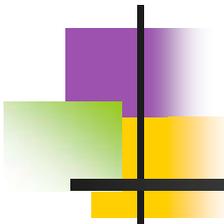
Proposals

- ***My recommendations - V***
 - ***Following issues can be addressed***
 - ***Requirement for higher temperature***
 - ***Performance prospective instead of safety prospective***
 - ***Requirement for coupling with heat applications***
 - ***Performance prospective instead of safety prospective, main challenge is the material to use the high temperature***



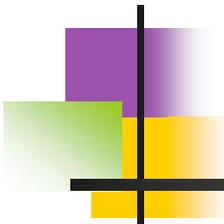
Proposals

- ***My recommendations - VI***
 - ***Following issues can be addressed***
 - ***Consideration on multiple modules on one site,***
 - ***per reactor year, per plant year, per site year?***
 - ***Change the goal along time?***
 - ***Safety requirement for spent fuel storage***
 - ***Dry storage?***



Proposals

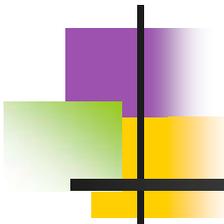
- ***My concerns - I***
 - ***Commercialize the modular HTGR***
 - ***Balance between safety and economy***
 - ***Is it possible to relax some requirement for certain SSCs?***
 - ***Diesel, PAMS, control room habitability system***
 - ***How to achieve economy features in future, besides the well know safety features***
 - ***We must take advantage of safety features***
 - ***Balance between advanced technology and existing technology***



Proposals

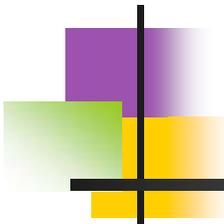
- ***My concerns - II***
 - ***The scope of BDBA***
 - ***Is there difference between BDBA and DEC?***
 - ***Is there additional requirement for DEC?***

 - ***Consideration on the double break of hot gas duct vessel***
 - ***The possibility to change the geometry of core***
 - ***Are the events comparable to that in LWR?***



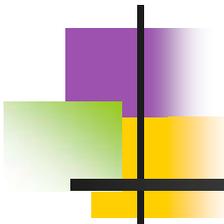
Proposals

- ***My concerns - III***
 - ***Distinguish between safety requirement, investment protection requirement, operation performance requirement***
 - ***It can be addressed both or not in safety requirement?***
 - ***It can be addressed in safety guides?***
 - ***It must be addressed in design***
 - ***Is it realistic or wise to compare the safety of different type of reactors now?***



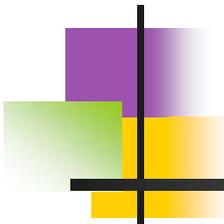
Personal opinions

- ***I have an impression:***
 - ***Current reference design for modular HTGR of pebble bed and prismatic type is feasible and acceptable***
 - ***Current safety philosophy for modular HTGR is feasible and acceptable***
 - ***Current performance and specification for current TRISO fuel is good enough, if combined with proper reactor design***
 - ***The design criteria sometimes is design***



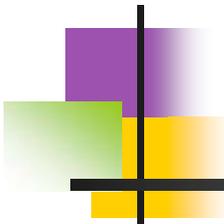
Personal opinions

- ***Biggest challenge for modular HTGR is the lack of operation experience***
 - ***Some are safety related, most are operation performance related***
 - ***The more experience and data are available, the less uncertainty and more confidence can be assumed***
- ***How to convince the public and experts outside HTGR community?***
 - ***Same framework, same or better goals***



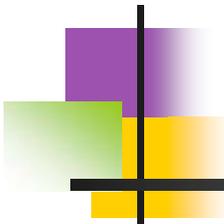
Personal opinions

- ***We must have a judgment in advance whether the requirement is achievable or not***
- ***Pu/Th fuel have no safety impact, or no additional requirement, if with proper neutronics design, following same safety requirement***



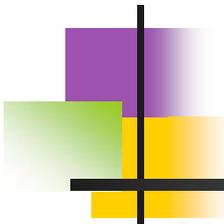
Personal opinions

- ***There is no substantial change of safety requirement to modular HTGR in the light of Fukushima accident***
 - ***The way to implement may change***
 - ***Design basis, emergency power supply***



Personal opinions

- ***The safety requirement itself can not be different for different types of reactors***
- ***The way to reach this requirement can be different***



Personal opinions

- ***Most important issues:***
 - ***Confinement***
 - ***Probabilistic safety goal for multiple modules***
 - ***Feasible to be implemented***
 - ***Comparable with other type of SMR***
 - ***Consideration of plants near user center***
 - ***The relationship between high level source term requirement and lower level requirement for fuel temperature***