RESPONSE TO "COMMENTS ON 'POSSIBLE DESIGN MODIFICATIONS OF THE ITER FUEL CYCLE'"

INTRODUCTION

Paul Dinner has made a number of comments[1] regarding my paper.[2] I would like to respond to his comments. I will use the same four points he used, namely,

1. conflict with ITER design goals and advice given to designers
2. downsizing of components leads to loss of operational flexibility
3. ITER specifications misunderstood
4. safety improvements.

My responses to the foregoing points follow.

CONFLICT WITH ITER DESIGN GOALS AND ADVICE GIVEN TO DESIGNERS

The modifications suggested did not "reduce the design margins," as suggested by Dinner. Those modifications only evaluated the required separation factor by other systems. An unnecessarily stringent design specification does not improve the performance of the system. This approach does not contradict the International Thermonuclear Experimental Reactor (ITER) design guidance because of the following:

1. The technologies used in our proposal are identical to those required by ITER CDA. The only difference is that the processing rates and the required separation factors are reduced.

2. Since all the fuel cycle components are contaminated by tritium, I do not see any additional technical risk. In fact, no technical reason was given to justify that tritium concentration in the protium stream has to be reduced to 10^{-9}.

3. The statement of "increase in size would not inherently undermine technical feasibility" is correct. However, increase in size will increase the cost and tritium inventory, and increase in the separation factor will increase complexity in the design.

DOWN-SIZING OF COMPONENTS LEADS TO LOSS OF OPERATIONAL FLEXIBILITY

Reference 1 early states that "'modifications' involve (trivially) the downsizing of the components," while Ref. 1 later states that "modifications . . . involve significant reduction to flows . . . ." The change from trivially to significant is not clear to me. The key point here is what is the source of protium to the plasma. There are three:

1. from deuterium-deuterium (D-D) reactions
2. from surface outgassing
3. from water leakage.

The protium produced by the D-D reaction has to be removed from the plasma. The outgassing protium is a potential problem only at the beginning of the reactor operation. The magnitude of this source was not specified by the ITER design. Even if this source term is large (which we are not certain), this problem can be taken care of by operating the reactor with modest protium concentration in the plasma during the first few shots. The reduction in the fusion power during those shots will be small.

As far as a water leak, there are more serious problems than protium separation. A small leak often is an indication of a forthcoming major leak. Therefore, it is necessary to fix the leak before it is too late. Also, the oxygen associated with the leak will certainly cause more problems than the protium.

ITER SPECIFICATIONS MISUNDERSTOOD

The point we tried to make here is that we have to separate the water from an internal source (coolant leak) from that from an external source (atmosphere driers). Water from an internal source can be returned to that source without detritiation (of course with the necessary cleanup system). Dinner stated that "We felt it prudent to assume that a significant fraction of the water contents of a coolant loop could be released . . . and detritiated. . . ." Why is this necessary? Even if this is necessary, why do we have to have such a high separation factor (10^{-12})?

SAFETY IMPROVEMENTS?

The sources of tritium to a subsystem, such as the neutral beam injection, are from back diffusion from the plasma and the tritium concentration in the gas feed. The total risk is approximately the summation of tritium sources from two sides. Therefore, reducing the tritium source in the feed side far below that from the plasma will not improve safety nor reduce the tritium inventory.

CONCLUSION

In conclusion, I still believe that the ITER fuel cycle CDA design can be improved significantly, with the same assumptions and the technology as required by the CDA.

It is true that I have participated in the ITER workshop and preparation and review of the "ITER Fuel Cycle" report. It is also true, but not mentioned by Dinner, that our concerns have been presented to the ITER fuel cycle team but not included in the report. For this reason, I believe it is reasonable to publish this concept in the open literature.

Dai-Kai Sze

Argonne National Laboratory
Fusion Power Program
9700 South Cass Avenue
Building 205
Argonne, Illinois 60439

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REFERENCES

1. P. J. DINNER, "Comments on 'Possible Design Modifications of the ITER Fuel Cycle,'" *Fusion Technol.*, **22**, 192 (1992).

2. D. K. SZE et al., "Possible Design Modifications of ITER Fuel Cycle," *Fusion Technol.*, **19**, 1601 (1991).