Evaluation Criteria

The APEX study is aimed at exploring innovative first wall and blanket concepts that can tremendously enhance the potential of fusion as an attractive and competitive energy source. These concepts should have high power density handling capability, high power conversion efficiency, potential to achieve high availability, and safety and environmental attractiveness. These features can lead to a reduction of the cost of electricity (COE) which is an important goal. In addition the concepts considered should meet the minimum functional requirements in a fusion system. Therefore, it is necessary to develop a set of evaluation criteria that help in the process of evaluating the concepts with respect to their attractiveness. In addition, these criteria provide guidance to the concept developers regarding improving the attractiveness of the concept by comparing design variations or material choices within the concept. An example for this is applying the evaluation criteria to compare the performance of the liquid wall concept with different liquid breeders (Li, Flibe, Sn-Li, Pb-Li).

Fig. 1 gives the different steps included in the APEX process. The concepts go through two major evaluations. The first one, referred to as the scientific evaluation, takes place in the early stage of the project and is aimed at determining if the concept can proceed into a more detailed level of analysis and design beyond the initial exploration phase. The scientific evaluation of the concepts will be performed based on the analysis provided in this report. Following more detailed analysis and design of the concepts, more information about the concept performance will be available to allow carrying out the feasibility and potential attractiveness evaluation at the end of Phase I of the project. This evaluation is aimed at determining the most promising concepts to move to the proof-of-principle phase with R&D requirements and experiments being identified. Following this evaluation further design conceptualization will be initiated for the most promising concepts. In this report, we provide the evaluation criteria developed for the scientific evaluation process. The criteria to be used in the feasibility and potential attractiveness evaluation process will be developed later.

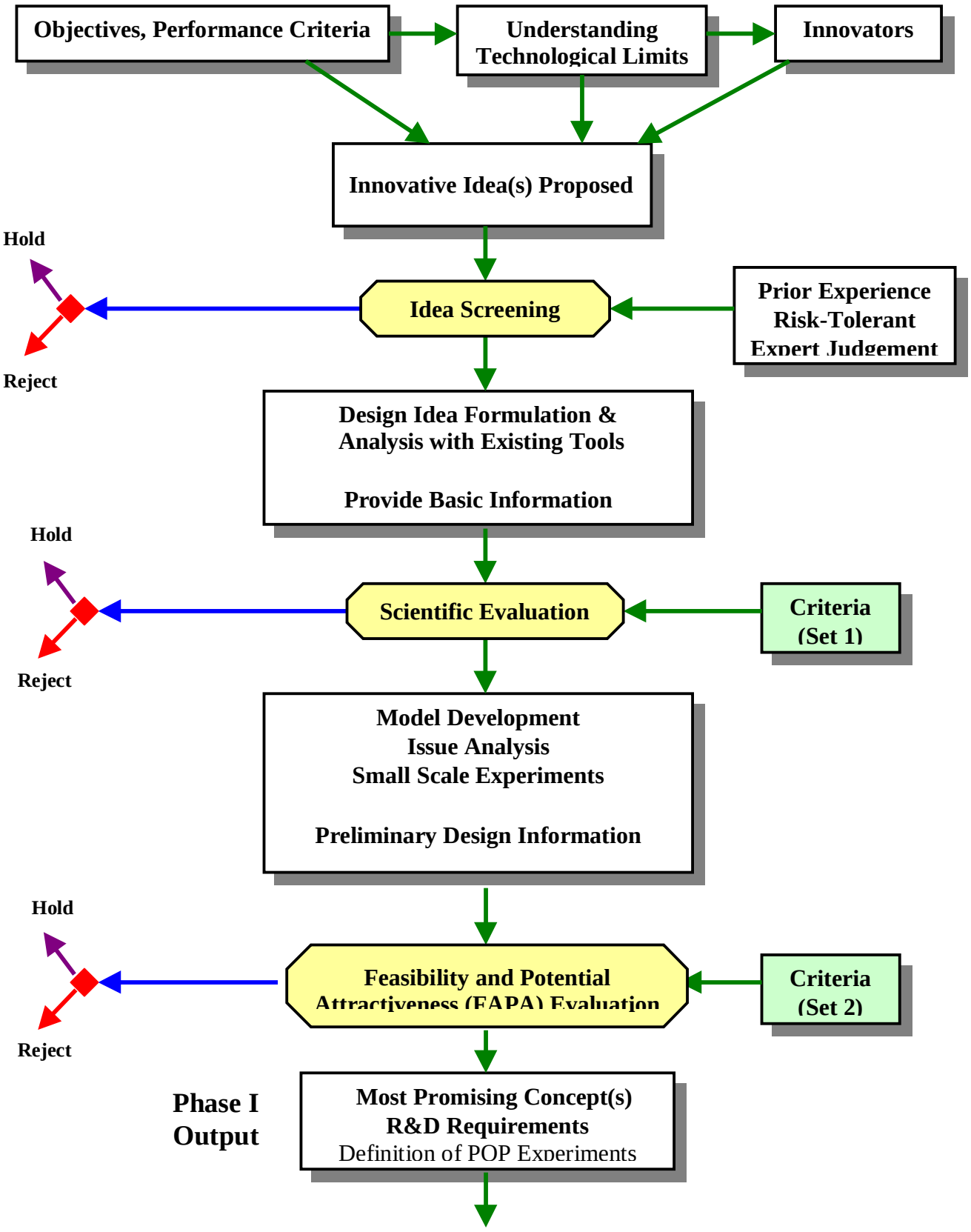

Fig. 1. Flow diagram of the APEX process.

Information Required for Scientific Evaluation

In order to facilitate performing the scientific evaluation a list of the information required has been developed. Although no detailed analysis is expected in the early stage of the concept development, the design parameters required are essential for the evaluation process and could be based on preliminary scoping analysis. These required parameters are listed in each chapter covering a concept. The required information include sketches of the geometry as well as information about the material used in each component. Thermal and mechanical performance parameters are also needed for the evaluation. The list includes also neutronics and activation parameters. The detailed list is given in Section 4.2.

Scientific Evaluation Criteria

The scientific evaluation criteria fall into four categories. The first one addresses the question of whether the concept meets the minimum functional requirements. The second one addresses the issue of the concept's potential for improved attractiveness. The third category relates to the design margins and uncertainties associated with the concept. The fourth category identifies the major critical issues and R&D needs. Detailed criteria were developed covering these evaluation categories. These detailed criteria are given in Section 4.3.

(1) Minimum Functional Requirements

These are the absolute minimum requirements for a concept to be proposed for use in a fusion power plant. The concept must satisfy the following requirements:

- Adequate tritium breeding
- Suitable tritium extraction
- Sufficient vacuum pumping
- Efficient power extraction

(2) Potential for Improved Attractiveness

The potential of the concept for improved attractiveness is measured by addressing several issues. These are listed below. A detailed list of criteria was generated for each of these issues and is given in Section 4.3.

- High Power Density and Heat Flux Handling
- High Power Conversion Efficiency
- High availability and reliability
- Attractive Safety and Environmental Attributes
- Low cost

(3) Design Margins and Uncertainties

This assesses how far are the calculated parameters from the operational design limits. The uncertainties in estimating the parameters used in the evaluation will be evaluated and compared to the design margins.

(4) Critical Issues and R&D Needs

This involves identifying the key issues for this design concept. The R&D required to resolve these issues will then be described. The facilities needed to perform these R&D activities will be defined.