

Chapter 1

INTRODUCTION

Among the nuclear power plants in existence or currently under design, the high temperature gas cooled reactor (HTGR) is unique in the ability to achieve core outlet temperatures approaching 1,000° C. This capability opens a wider spectrum of industrial applications for the utilization of nuclear fission as a broad based energy source. Currently, nuclear energy produces approximately 17% of the world's total electrical generation. Overall, about 30% of the world's primary energy consumption is used for electricity generation, approximately 15% is used for transportation and the remaining 55% is converted into hot water, steam and heat. This indicates that the potential for applications of nuclear energy in the non-electric sector may be quite large, although currently only a few nuclear plants are used for non-electric applications [1].

It was with the intent to develop and demonstrate high temperature applications of nuclear power that the Japan Atomic Energy Commission recommended the construction of the High Temperature Engineering Test Reactor (HTTR). Construction of the helium cooled 30MWt HTTR began in March, 1991, at the Oarai Research Establishment site of the Japan Atomic Energy Research Institute (JAERI).

It was during this time that JAERI offered the HTTR to Member States of the International Atomic Energy Agency (IAEA) as a test facility for international cooperation in the design and evaluation of heat utilization systems for demonstration while connected to the HTTR. Subsequently, in 1994, the IAEA established the Coordinated Research Programme (CRP) on "Design and Evaluation of Heat Utilization Systems for the HTTR".

Member States participating in this CRP included China, Germany, Indonesia, Israel, Japan, Russia and the United States of America. The CRP addressed the following heat utilization systems:

- Steam reforming of methane for the production of hydrogen and methanol
- Carbon dioxide reforming of methane for the production of hydrogen and methanol
- Thermochemical water splitting for hydrogen production
- Combined coal liquefaction and steam generation
- High temperature electrolysis of steam for hydrogen production

JAERI's objectives for the HTTR included the establishment and upgrading of the HTGR technology basis, the conduct of innovative basic research on high temperature engineering and the demonstration of high temperature heat applications of nuclear energy [2]. The goals of this CRP complemented these objectives and included:
a.) Defining the R&D needs remaining for the above mentioned heat utilization systems

prior to coupling to the HTTR, b.) Defining the goals of the utilization systems for demonstration with the HTTR, c.) Preparation of design concepts for coupling selected systems to the HTTR and performance of associated safety evaluations, and d.) Checking of the licensibility of selected systems under Japanese requirements and conditions.

In addition to the heat utilization systems indicated above, testing of advanced intermediate heat exchangers and coupling the HTTR to the gas turbine for the generation of electricity were examined under the CRP.

This TECDOC documents the activities of Member State participants in the CRP and provides detailed analyses associated with each heat utilization system including:

- the determination of the priority for its connection to the HTTR
- the description of the system process and engineering design, modes of operation and system safety requirements
- identification of goals to be achieved from the demonstration with the HTTR
- the experiences associated with the system by Member States in conjunction with their individual national gas cooled nuclear reactor programmes

A critical analysis of the differences between the use of conventional heat sources such as fossil fuels and the HTGR related to the environment, economics, and other energy and technological considerations was also conducted.

REFERENCES TO CHAPTER 1

- [1] CLEVELAND, J., LEWKOWICZ, I., "Status of the Coordinated Research Programme on Design and Evaluation of Heat Utilization Systems for the HTTR", 2nd International Conference on Multiphase Flow, Kyoto, Japan, (April 1995).
- [2] NISHIHARA, T., HADA, K., SHIOZAWA, S., "Japanese HTTR Program for Demonstration of High Temperature Applications of Nuclear Energy", IAEA-TECDOC-923, Vienna, (January 1997).