IAEA ASSET SERVICE --- A KANUPP PERSPECTIVE

BY

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INTRODUCTION

As you all know IAEA has been providing ASSET Service since 1986. It is a mechanism for drawing and disseminating specific and generic lesson from a significant event.

Like many other operating organizations, KANUPP has also benefitted from its in-depth technical exchange experience which has resulted in significant improvement in the level of operational safety. The Asset mission, which visited KANUPP in connection with fuelling machine locking problem in 1989, triggered many actions which were responsible for improvement of overall safety of the plant.

KANUPP REACTOR FUEL CHANNELS PROBLEM – A BRIEF HISTORY/BACKGROUND

In 1983 the problem at reactor channel G-12 started. The fuelling machine would not lock onto the south end-fitting of this channel because the end of the channel was retracted relative to the neighbouring channels. Changes were made to the fuelling machine programme to enable it to fuel the channel G-12 on auto. The comparative expansion measurements of channel G-12 with other channels, taken in 1987, revealed that at cold shutdown state (120°F) the channel retracted 0.4" from other channels and on heating (at 538°F) it moved only 0.176" compared to 0.55" for other channels. The thermal expansion should move the free end of the channels at least 0.475" when heated from 120°F to 400°F. From 1987 onward the fuelling in this channel was performed in plant shutdowns only. In year 1989, reactor channel F-15 was also found to be retracted by 0.375". The expansion bellows of 14 channels were found to be leaking. ( The testing in 1993 revealed that bellows of six channels were leaking ). The sag of channels G-12 and F-15 (cold, defuelled and dry) was measured to be 2.0" and 0.47" respectively.

ASSET MISSION TO KANUPP – SEPTEMBER 1989

In May 1989 PAEC officially requested IAEA for ASSET Service to look into KANUPP fuel channel locking problem. The Agency formed a team of 4 experts consisting of two experts from Canada, one from Germany and one, the team leader, from IAEA. Names of the mission members were as follows:

1- Mr. E. ADAMS, Canadian General Electric, Canada
2- Mr. A. OWEN, Ontario Hydro, Canada
3- Mr. STEINKAMP, Siemens, Germany
4- Mr. B. THOMAS, IAEA (Team leader)

The mission visited KANUPP from 18th to 29th September 1989.

REPORT OF ASSET MISSION – RECOMMENDATIONS

The team inferred that the retracted cold shutdown position of channel G-12 was due to the south end-fitting being jammed and not able to move on its bearing. They also concluded that annulus gas system had not been operated correctly and was prone to contain both moist air and heavy water over the years. They suggested that carbon steel lattice tube had corroded and the gap between the end-fitting and the lattice tube was filled with corrosion products. When the channel was heated, the diametral expansion locked the south end-fitting in the lattice tube and prevented axial movement. The team also suggested that the behavior of channel F-15 was probably due to the same phenomenon.
As a result of ASSET review, it could not be determined that locking problem of the fuelling machine on the G-12 reactor fuel channel was due to a generic problem of corrosion in the annulii.

Along with recommending some short-term measures like defuelling of channel G-12 and F-15 and improvement in CO₂ annulus system, the ASSET mission recommended removal of pressure tube and calandria tube of channel G-12 to confirm the cause of the channel retraction and determination of the extent of damage to the tube.

Besides the above-mentioned specific recommendations, the ASSET team gave some general recommendations for enhancement of overall safety of the plant. These general recommendations provided a sound basis for KANUPP to start on safety improvement programme and to achieve enhanced plant safety. The IAEA ASSET mission, in fact, proved a turning point towards strengthening and enforcement of an effective operational safety programme for KANUPP.

IAEA TC PROJECT PAK-9/010

Since implementation of ASSET recommendations at KANUPP was not possible without access to proprietary CANDU technology, the IAEA was approached for assistance which approved a four-year Technical Cooperation Project (PAK-9/010), and as a result the Canadian government allowed experts to assess and plan the required safety improvements under the auspices of CANDU Owners Group (COG). Later, the ASSET recommendations and other issues concerning safety improvements were consolidated in an Integrated Safety Review Master Plan (ISARMAP). The plan was submitted to IAEA in 1991 and was approved by IAEA Steering Committee. The ISARMAP activities are divided in five broad areas as:

a) Project Management
b) Aging
c) Obsolescence
d) Operational Safety
e) Design Safety Improvements

IAEA STEERING COMMITTEE

Since the activities related to ISARMAP are multidimensional and involve safety implications, it was essential that the required resources be coordinated internationally and managed judiciously for prompt and optimum execution of the tasks. For this purpose, IAEA setup a Steering Committee consisting of experts from IAEA, Canada, KANUPP, and one other CANDU operating country (Argentina) to guide, prioritize, adjust and approve the implementation of this plan from time to time. The Steering Committee meets at least once a year to review the progress of implementation of ISARMAP tasks, amend or add tasks as necessary.

CANADIAN ASSISTANCE

It was strongly realized that Canadian technical support is essential for accomplishment of many of the tasks listed in ISARMAP. Consequently, on April 25, 1991, PAEC signed a bilateral agreement termed as SOK-II with COG for providing technical support in the implementation of ISARMAP tasks approved by IAEA Steering Committee and as permissible under the Canadian government export policy.
STATUS OF ISARMAP TASKS

Some of the tasks in ISARMAP have been completed. One of the tasks of the ISARMAP was Fuel Channel Integrity Assessment (FCIA) which, as mentioned earlier, was included in the plan as per recommendation of ASSET mission, 1989. For FCIA, a comprehensive programme in collaboration with AECL of Canada was chalked out. The task was undertaken in October - December 1993. The inspection, cutting and removal of channel G-12 was carried out successfully. The channel openings were plugged with dummy end-fittings by the state-of-the-art bellow welding machine. Seven other channels including F-15 were also inspected. The results of ISI of eight selected channels were very favourable. Channel F-15, which had previously been taken out of service (along with G-12) was normalized since inspection results were quite good and it was also confirmed from the previous record that its length was shorter since installation. It may be of interest to note that the inspection by AECL-Research concluded that the seizure of G-12 inboard bearing was a non-generic problem. The CO₂ system was not the root cause for sagging of channel G-12 as suspected by IAEA ASSET mission.

The Fuel Channel Integrity Assessment and other completed tasks has helped to restore confidence in the safe operation of KANUPP. Based on inspections and implementations of several safety related tasks, we can now rightly expect that KANUPP should be able to operate safely up to and even beyond its design life i.e after years 2002 provided the other on-going tasks to resolve aging and obsolescence problems are also executed. Some of the tasks which have already been started, or to be started shortly, are as follows:

- **FCIA Follow-up:**
  7 to 13 new and seven already inspected fuel channel will be inspected in 1998. Another fuel channel will be removed for metallurgical examination to confirm fuel channels suitability for further service.

- **Radiation Instrumentation:**
  Commissioning of four new stack radiation monitoring and three high range gamma monitoring channels have been completed. Tritium in air and tritium in light water systems are being commissioned.

- **Upgrading of Computers, Control & Instrumentation:**
  The task is being pursued actively. All the equipment has arrived and are being tested at KANUPP. The commissioning and operational checks are expected to be completed by July, 1997.

- **FSAR Update:**
  Phase-I of KANUPP FSAR has been updated. The results of Phase-I indicated that plant Safety Systems are adequate to safely shutdown the Plant in case of large break LOCA and other transients. Preparation for phase-II of the task is underway. FSAR Update Phase-II shall be completed during 1996-97.
PSA Level 1

Updating of Event Trees was completed in February, 1996 based on recommendation of the IAEA Expert Review Mission in April 1995, KANUPP Operating Experience and result of Phase-I of FSAR Update. Fault Trees have been developed and reviewed by IAEA expert during a recent visit to KANUPP from 12 to 23 May, 1996. Qualitative results are expected by December 1996.

Booster Rod Cooling

KANUPP has abandoned use of boosters as a policy to circumvent the safety concern. Removal of the booster rods is also being planned in due course.

Secondary Heat Sink

A conceptual study at KANUPP has been reviewed by an Ontario Hydro Expert in June, 1994. All the equipment required for the new system of Emergency Feed Water (EFW) to boilers have been ordered and the delivery expected by June, 1996. Connection of new piping to the Feed Water System will be undertaken in the next long shutdown. The system is expected to become operational by November, 1996.

Emergency Power Supply

The detailed engineering of auxiliaries is in hand. Civil work for installation of the Diesel Generator has been started. Tender for the bus bar duct have been invited and evaluated. Approval of the same is in process. The Diesel Generator has already been received from Mirrless Blackstone.

Improvement in Containment Testing Pressure

Test has been successfully performed at 5 psig instead of usual 2 psig. Feasibility to conduct test at half or full design pressure is being explored with the help of Canadian experts. Scoping visit of two Canadian experts from N.B. Power and Hydro Quebec Canada to KANUPP is scheduled in first week of June, 1996, to discuss the programme of testing the containment at high pressure.

Hazards Review

Seismic

Scheme for anchoring of Control Room panels was reviewed by CHASNUPP and requires re-analysis which is being undertaken. The IAEA Steering Committee concluded in December, 1994 that the long-term recommendations are not essential and be given low priority. As such the outstanding part of the geological work shall be taken up in due course.

Equipment Qualification

A dedicated Equipment Qualification (EQ) group, led by an engineer trained in E.Q, has been formed. The group has started working towards establishing a systematic E.Q. program following recommendation of the expert mission. The upgrading of junction boxes and cable conduits against moisture ingress is in hand.
CONCLUSION

I can say without reservation that IAEA ASSET mission to KANUPP in 1989 proved to be a turning point in the formation and implementation of an effective policy to achieve overall improvement in plant safety.

The mission had identified some good practices and generic lessons learnt from operating events and accidents elsewhere. The implementation of these good practices and lessons learnt would prove useful and effective in prevention of incidents at the plant. The ASSET mission gave KANUPP personnel also an opportunity to exchange and update knowledge and experience with the experts. It was a good training opportunity for our engineers to learn the methodology of ASSET review process.

In short, apart from its delegated mission, the ASSET mission played a very vital and important role in assisting KANUPP in the development of an effective safety enhancement programme which in turn helped achieve a safe and reliable plant operation.