Reportable Event Report on Maanshan Nuclear Power Station Unit 2
Reactor Scram Incident
(RER-94-32-002)

1. Description of Event

On September 1, 2005 Maanshan Nuclear Power Station Unit 2 was reduced to 51% of rated thermal power and generating 481MWe prior to the projected arrival of typhoon Talim. At 6:42 a.m. the main transformer differential protective relay (587MT) phase B as well as unit differential relay (587U) phases B and C were actuated, causing the generator to trip, followed by the main turbine trip and reactor scram. After the reactor scram, aside from the tripping of the containment fan cooler Train A GN-F008 electrical relay, all other safety system equipment operated normally. This abnormal event was determined to have no safety significance without any radioactive material release and thus be classified as a level 0 event on the International Nuclear Event Scale (INES).

2. Cause of Event

The cause of this event was a damaged support insulator (as attached picture) that caused flash over to ground in the section G2M12 of a gas insulated bus (GIB). This GIB led the phase B bus of the main transformer to the switch yard. The faulty current was detected by both the 587MT and 587U differential protective relays and they were consequently actuated, causing the main generator and the turbine to trip as well as the reactor to scram. This incident also actuated the Auxiliary Feed Water System (AFWS) and the Emergency Chilled Water System following reactor scram.

3. Cause Identification and Corrective Measures

(1) Cause Identification

The actuation of the 587MT and 587U relays and related phenomena

confirm that the cause of this incident was the flash over of the support insulator as described above. The switch yard transient data recorder showed that there was no system high voltage transient before the incident, thus the damage of the insulator could have been the result of deterioration rendering it incapable of handling the normal operating voltage. After the failure of the insulator, it broke into pieces. From a preliminary reconstruction of the pieces it was discovered that internally there were some black burn traces. This was the result of a large amount of current whose electro-magnetic force caused the disintegration of the insulator. On the basis of the insulator's damaged condition and up-to-date data, the preliminary conclusion is that the root cause could be that the insulator was somewhat cracked or creviced, rendering insufficient voltage carrying capability and thus causing flash over to ground. The determination of a definite cause awaits further laboratory analysis.

(2) Corrective Measures

After this incident, Maanshan Nuclear Power Station inspected and repaired the affected GIB, including: (a) replaced the insulator in the failed GIB section and repaired the conductor and piping, (b) all contaminated GIB sections were cleaned and reassembled, (c) after reassembly, the GIB underwent insulation tests and a step-up voltage test (to 105% of rated 345kV).

In addition, Maanshan Nuclear Power Station also asks for help from the Material Research Laboratory of the Industrial Technology Research Institute to conduct a comparative test on both the faulty insulator and the intact insulators. The result of the study and the cause of the failure will be guided to take future corrective measures. Currently the manufacturer's instructions does not include the GIB in any recommended maintenance procedures except for an SF_6 gas content test. This test includes monitoring the pressure of the SF_6 gas during operation and regular measurement of moisture content. Upon inquiry of those responsible for installing the GIB at Taipower and the local

manufacturer, the Chung Hsin Electric & Machinery Mfg. Corp. Ltd., it was learned that they provided no information on routine maintenance procedures. Maanshan Nuclear Power Station planned to ask domestic research institutes to assess the feasibility of installing partial discharge ultra-sound equipment for early detection of GIB insulation deterioration and other abnormal phenomena.

4. Operation of Safety Systems

Because of stringent requirements of nuclear safety regulation, AEC regards any automatic reactor scram as a significant event and requires approval for restart. As the process of automatic reactor scram involves numerous safety systems actuation, each automatic reactor scram therefore becomes a good opportunity to examine functionality of the safety equipment. A detailed investigation on the involved safety systems and relevant parameters during the shutdown showed that the reactor safety systems were working properly, reactor was secured, and there was no environmental impact outside the nuclear station. In the process of shutdown, the containment fan cooler Train A GN-F008 tripped when the electrical bus was slow-transferred. The reason of this failure was that the auxiliary relay 42-X2 was constantly energized and build-up heat led to a deformation of the mechanism, resulting in its malfunction. Taipower has adopted corrective measures to replace related components and planned for subsequent routine maintenances.

5. AEC Regulatory Measures

On September 1, 2005, immediately after Taipower notified AEC of this incident by phone, the Council immediately inquired the condition of the reactor unit and ascertained that the unit had been safely shut down. Meanwhile, the AEC resident inspector was notified to obtain first-hand information on-site and to investigate the cause of the reactor scram as well as follow-up corrective activities. In addition to the on-duty inspector, an AEC senior inspector was sent to the

station to assist in the investigation. After Taipower identified the cause of the reactor scram and took corrective measures, it submitted a request to AEC for unit restart in accordance with established restart regulations. A review meeting was held at AEC headquarters on September 9. Based on the review results that there were no more safety concerns, AEC approved restart request for Maanshan unit 2 at 2:00 p.m. on September 10 with follow-up regulatory measures.

Damaged Insulator at 0° Position

Normal insulators separated by 120 degrees.

Photo: Normal and Damaged Support Insulators