

AEOD ENGINEERING EVALUATION REPORT

UNIT: Sequoyah 1/2 and D. C. Cook 1/2  
DOCKET NO.: 327/328 and 315/316  
LICENSEE: TVA and Indiana and Michigan Electric  
NSSS/AE: Westinghouse/TVA and  
Westinghouse/AEPSC

EE REPORT NO. AEOD/E316  
DATE: July 11, 1983  
EVALUATOR/CONTACT: D. Zukor

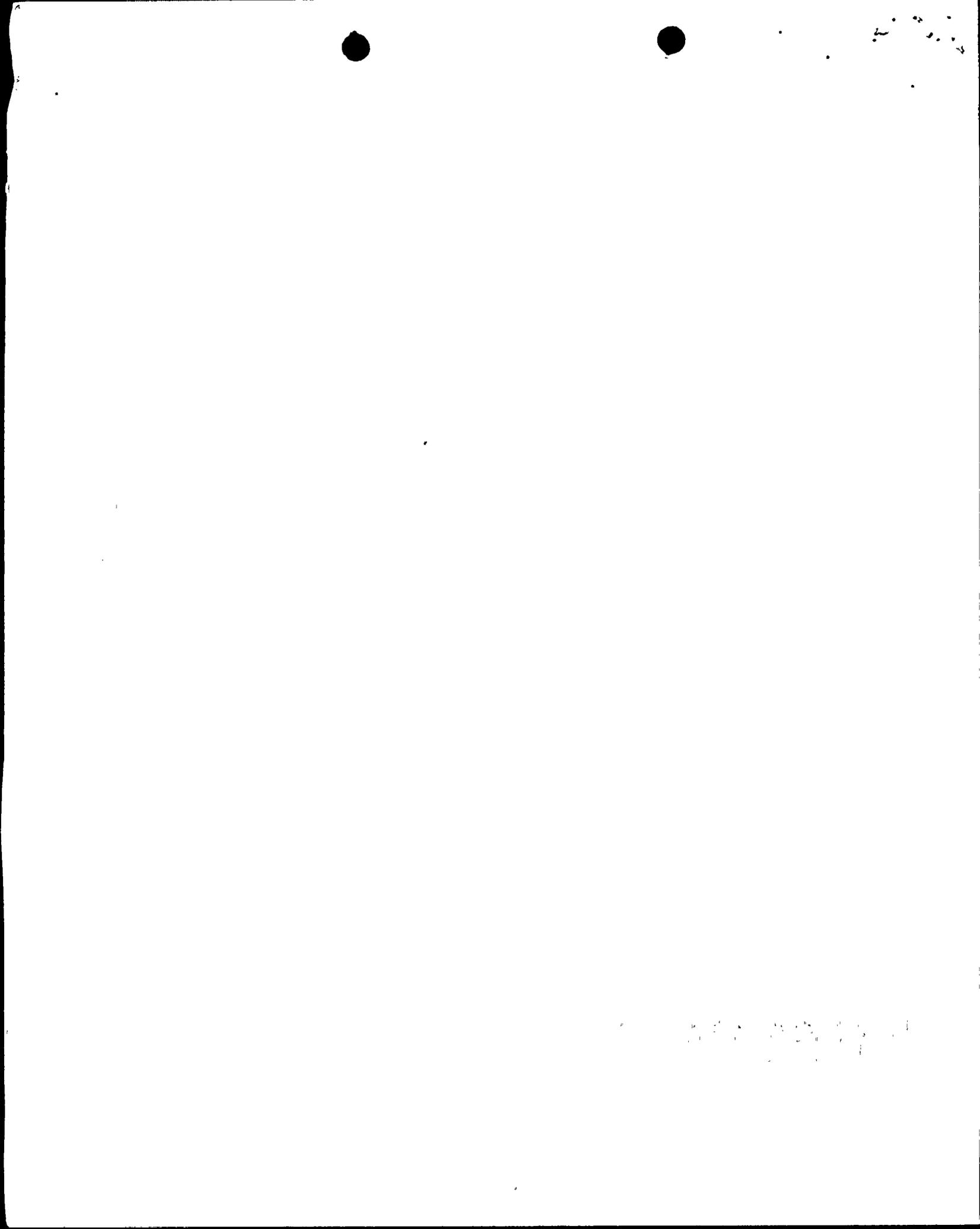
SUBJECT: FROZEN ICE CONDENSER INTERMEDIATE DECK DOORS

EVENT DATES: Many

SUMMARY

The ice condenser system is a passive system designed to limit the peak pressure spike in containment following a LOCA. To function properly all inlet and outlet doors must open when required to allow steam to pass through the ice condenser. There have been a number of failures at Cook and Sequoyah involving the intermediate deck doors freezing shut. This does not appear to be a safety concern unless large numbers of doors fail. Improved surveillance and maintenance procedures have effectively prevented large numbers of failures. Isolated individual door failures do not appear to jeopardize the ability of the ice condenser to perform its safety function.

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DISCUSSION

The Ice Condenser System is designed to be a totally passive system. It provides a means of absorbing the energy released to the containment following a Reactor Coolant System or steam pipe break. The ice condenses the steam thereby reducing the maximum containment pressure. An isometric of the ice condenser system is shown in Figure 1. When the pressure across the lower inlet doors exceeds 1 psfd, these doors open, directing steam up through the ice baskets and out through the intermediate deck doors, the top deck doors, and ultimately into the upper containment. The intermediate deck doors are immediately above the intermediate deck. The top deck doors are not shown on the figure.

During normal operation, the air handling units (AHU) and air distribution ducts direct cool air around the ice baskets to keep the ice from melting.

The intermediate deck doors form the ceiling of the ice bed region and the floor of the upper plenum. They also act as a walking surface which is used for maintenance of the AHU's, and inspection of the ice bed. There are 192 intermediate deck doors. Only three plants are currently equipped with ice condenser containments: Sequoyah 1 and 2, Cook 1 and 2 and McGuire 1 and 2.

FINDINGS

The following events have been reported involving freezing of the intermediate deck doors at Sequoyah and Cook. McGuire has reported no events where the intermediate deck doors froze shut.

Sequoyah:

| <u>Unit</u> | <u>Date</u> | <u>LER</u> | <u>EVENT</u>  |
|-------------|-------------|------------|---|
| 1           | 10/16/80    | 80-170     | Two intermediate deck doors were found frozen closed due to failure of heat tape on AHU drain.  |
| 1           | 12/16/80    | 80-203     | Leaking AHU drain line flange cause door under AHU 3A to freeze closed.   |
| 1           | 12/29/80    | 80-205     | Ice in the defrost drain line caused two intermediate deck doors to freeze shut below AHU 3A on two occasions.  |
| 1           | 1/9/81      | 81-002     | Loose flange bolts caused AHU 3A defrost drain line to leak into two intermediate deck doors freezing them shut.  |
| 1           | 1/16/81     | 81-008     | Due to a fuse failure in one section of the heat tape controller, water froze in the drain lines of three AHUs-6A, 8A, and 8B causing the lines to rupture. Three intermediate deck doors were found frozen closed. |

# Ice condenser

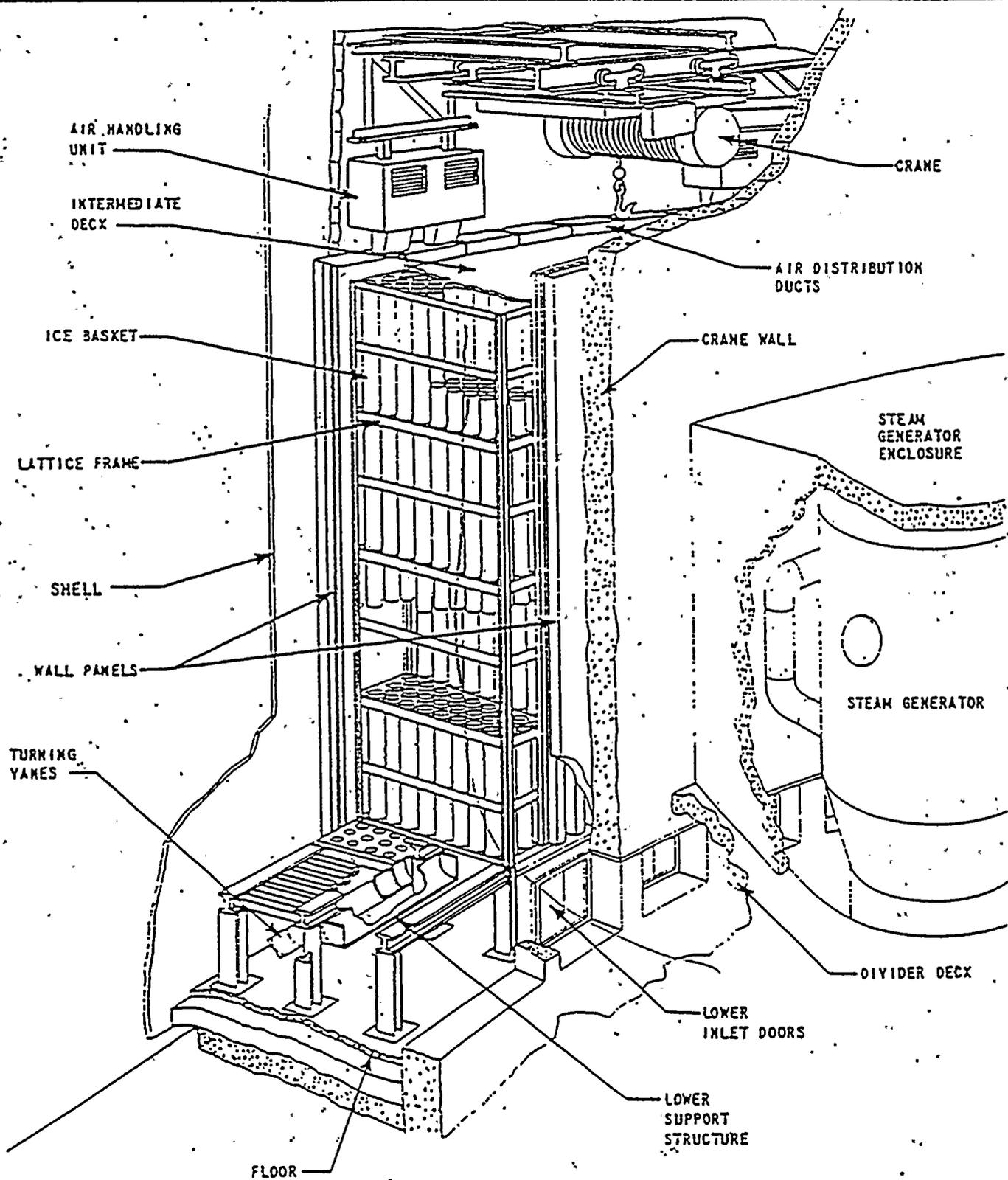
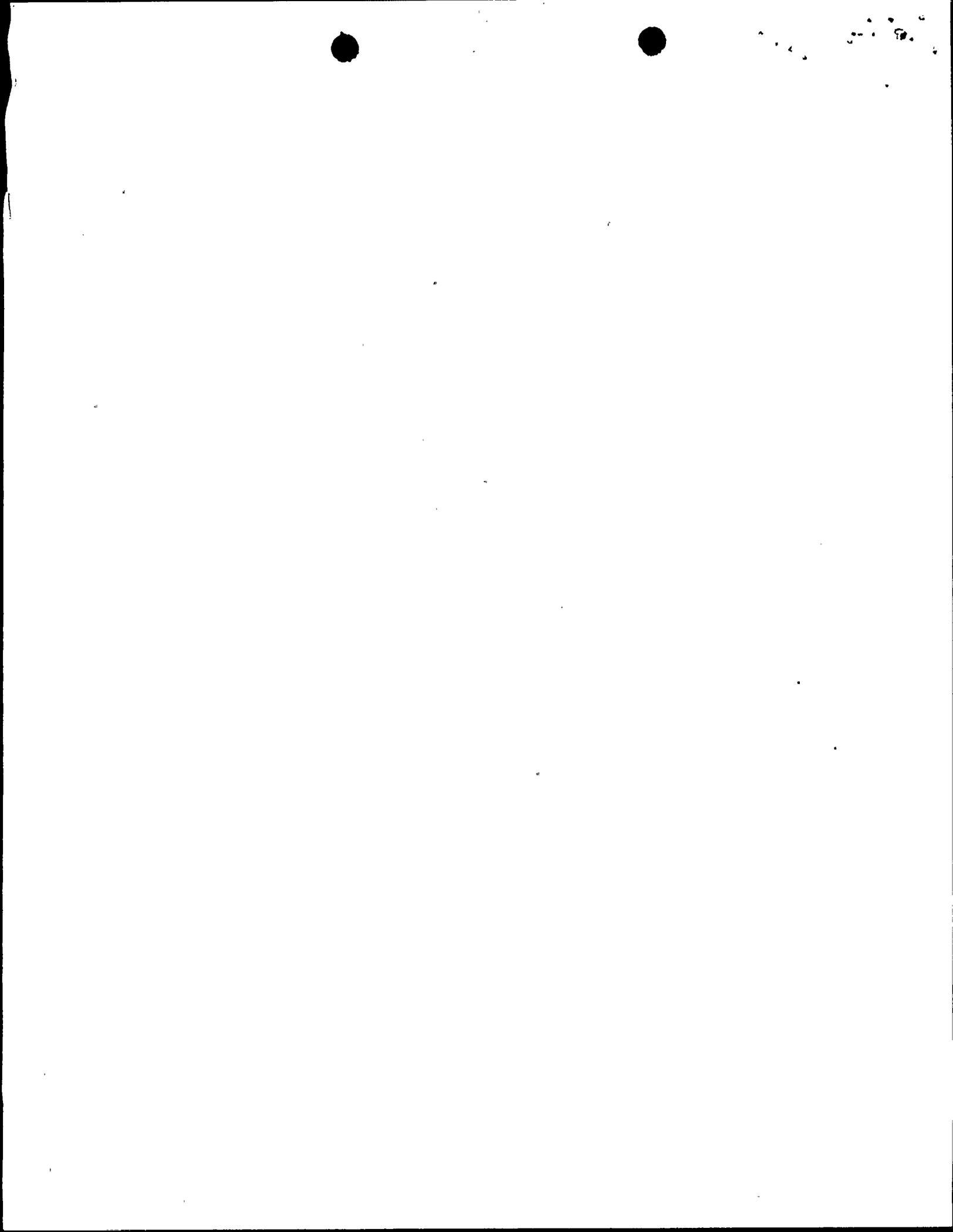


Figure 1 Isometric Of Ice Condenser

| <u>Unit</u> | <u>Date</u> | <u>LER</u> | <u>EVENT</u>  |
|-------------|-------------|------------|---|
| 1           | 6/29/81     | 81-073     | Ice condenser intermediate deck doors were frosted. Damaged tape seals on the upper deck doors allowed moisture to drip from the upper deck doors onto the intermediate deck doors. |
| 1           | 8/22/81     | 81-105     | AHU condensate drain pan heater mat failed permitting the drain pan to ice over and allow water to spill into the Bay 14 intermediate deck doors. The door was iced over.           |
| 2           | 1/3/82      | 82-001     | Condensate on I-Beams under top deck doors dripped into intermediate deck door 9B freezing it shut.   |
| 2           | 4/26/82     | 82-052     | AHU 9B drain pan apparently installed out of level allowed ice to build up and ultimately caused intermediate deck doors below it to freeze closed.                                 |
| 1           | 5/28/82     | 82-065     | A leaking drain line from AHU 3A caused one ice condenser intermediate deck door to freeze shut.  |
| 2           | 6/9/82      | 82-077     | A broken solder joint in an AHU drain line allowed water to spill onto one intermediate deck door and freeze it shut.   |
| 1           | 7/6/82      | 82-093     | Failure of heat tape allowed water to freeze in AHU 12A causing the line to rupture. Three intermediate deck doors were found frozen closed.  |
| 2           | 3/24/83     | 83-049     | Leaks in condensate drain lines of AHU 13 and 14 allowed water to drip down onto an intermediate deck door in bay 11 and freeze it shut.  |

D. C. Cook:

| <u>Unit</u> | <u>Date</u> | <u>LER</u> | <u>EVENT</u>  |
|-------------|-------------|------------|---|
| 1           | 7/5/79      | 79-034     | Two ice condenser intermediate doors could not be opened because of ice buildup around the doors caused by water leakage from an AHU.   |
| 1           | 7/9/79      | 79-036     | Two intermediate deck doors were found to be frozen shut. The cause of the ice buildup could not be determined.   |
| 1           | 8/31/79     | 79-045     | One intermediate deck door frozen shut.   |
|             | 9/17/79     |            | Six intermediate doors frozen shut. Prior to each event (8/31/79 and 9/17/79) the ice bed temperature was decreasing and this in combination with the high summer humidity, caused condensation.  |
| 1           | 11/16/79    | 79-060     | A plugged AHU drain line caused drainage to overflow and spill into the door. The door below the AHU then froze shut.   |
| 1           | 5/22/80     | 80-010     | Eight intermediate deck doors were found frozen shut. Top deck door divider beam condensation was the source of the water.  |
| 1           | 8/17/80     | 80-021     | Two intermediate deck doors were found frozen. The source of the moisture was condensate off of the Top deck door divider beams.  |
| 1           | 9/17/80     | 80-024     | Twenty-one intermediate deck doors were found frozen due to moisture condensing on the top deck door divider beam. A design change was begun which would insulate the beams to prevent condensation. Surveillance was increased from three times weekly to daily. |
| 2           | 7/29/81     | 81-038     | One intermediate deck door was found frozen shut.   |



| <u>Unit</u> | <u>Date</u> | <u>LER</u>               | <u>EVENT</u>  |
|-------------|-------------|--------------------------|---|
|             | 8/10/81     |                          | Another intermediate deck door was found frozen shut. Both events (7/29/81 and 8/10/81) were attributed to a broken AHU drain line. |
| 1           | 12/23/82    | 82-109<br>also<br>83-002 | A plugged drain line in an AHU caused one intermediate deck door to freeze shut.  |
| 1           | 12/30/82    | 82-110<br>also<br>83-001 | One intermediate deck door found frozen shut. No cause could be found.  |

The only instances where a large number of doors failed occurred at Cook 1. Following the 9/17/80 event the top deck door divider beams were insulated which effectively eliminated further problems with many doors failing simultaneously. In all other cases only one or two doors froze shut, usually due to some problem with the AHU above it.

Analysis and full-scale testing have shown that the doors could take 140% of the maximum pressure load predicted to occur during a LOCA. This indicates that about 50 doors need to freeze shut before the operating doors may be damaged by the pressure load. One must also consider the effect of steam channeling of the ice when large numbers of doors fail. This occurs when there are insufficient inlets or outlets for the steam flow through the ice baskets. In this case, the steam carves a direct path through the ice and adequate condensation does not occur and adequate pressure suppression does not take place. Although the technical specifications require that all doors be operational, it seems unlikely that steam channeling would occur following a LOCA unless many adjacent doors failed simultaneously. No analysis could be found giving the number of doors which would have to fail before the ice condenser could not adequately condense the steam from a LOCA.

#### CONCLUSIONS

Since there have been no significant multiple failures at either Cook or Sequoyah recently, it appears that improved maintenance and surveillance have solved most of the freezing problems. It should also be noted that most of the problems occurred when the plants were fairly new and that all incidents of this type decreased after the plant had been in operation a few years. The problem of a few isolated cases of frozen intermediate deck doors will persist because of the atmospheric conditions in containment which promote condensation onto any surface; however, this does not appear to jeopardize the ability of the ice condenser unit to perform its safety function. AEOD plans no further action on this issue.