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to NJD-11, "XE-1 Safety Evaluation Report - Phase II"

Subject: Supplement 2 to NJD-11, "XE-1 Safety Evaluation Report - Phase II"

INTRODUCTION

Paragraph 3.1.2.j of the XE-1 Operating Limits Document - Phase II, NJD-13, states "Engine power testing utilizing hydrogen coolant will not be initiated or continued at any time the ground level winds are from the 90 degrees sector bounded by the compass directions of 281 degrees and 11 degrees". As discussed in paragraph 5.5.4 of the XE-1 SER - Phase II⁽¹⁾, the intent of this limitation was primarily to protect operating personnel from radiation hazards should evacuation of the CP become necessary following an accident involving a major release of fission products. Secondly, the wind restriction protected the stand from the possibility of adverse heating effects of a "buoyant flame" plume during operations involving low hydrogen flow rates.

In view of certain facility and procedural modifications which protect against the above mentioned hazards and in the light of newly acquired operating experience, it is deemed appropriate to re-evaluate the necessity of such rigid wind restrictions on XE test operations.

EMERGENCY EVACUATION OF CP AREA

If personnel were forced to evacuate the CP area because of fire or the introduction of radioactive gases (essentially iodine) following a major accident, the evacuation may have to be conducted through a relatively high radiation field from ground deposition of radioactive particulates.

INFORMATION CATEGORY
UNCLASSIFIED

E.H. Hammer 6/13/69
Authorized Classifier Date

(1) NJD-11, "XE-1 Safety Evaluation Report - Phase II", dated September 1968.

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The ETS-1 facility has been modified to provide evacuation holding areas that protect personnel from both underground and aboveground hazards until outside radiation levels are low enough for egress. The entrances of the Main Tunnel, Utility Equipment Building, and Control Point have been designated as the evacuation holding areas. These areas are adequately shielded from the anticipated outside radiation environment and are sufficiently removed from potential fire locations so as to protect personnel from an underground fire. Metal weather stripped doors and isolation from the ventilation system provide for an air tight enclosure that protects against hazardous gases entering the holding areas. The air volume of these holding areas (approximately 12,000 cubic feet) is such that 100 people could remain at least four hours before the atmosphere reaches a CO₂ content of 3 percent by volume and evacuation is necessary. Also included but not considered in determining the above retention time are CO₂ removal equipment and cannister type gas masks which are effective against combustion products and against radioiodine. These masks are in sufficient quantity to provide one for each man in the Control Point Building.

Run day emergency procedures provide for two buses on standby in a safe location for evacuation purposes. The buses are located at the H&K junction (approximately one mile south of the CP) unless weather conditions dictate a more suitable location. The two buses are adequate to accommodate all the operating personnel and it is conservatively estimated that the evacuation can be effected with less than ten minutes exposure in a high radiation zone.

Table 5.1 of XE-1 SER - Phase II gives a whole body exposure limit of 12 REM/accident. Based on the above estimate of 10 minutes exposure in a high radiation field surrounding the Control Point Building during evacuation, personnel exposure during evacuation can be limited to 12 REM if the radiation field at the Control Point exits does not exceed 72 R/Hr at the time of evacuation. While the Control Point Building holding areas are suitable for retention of personnel for at least four hours, it is conservatively assumed that evacuation shall be achievable one hour after an accident involving a major release of fission products. On this basis, testing when the wind is directed from the test stand toward the Control Point can be permitted if the radiation dose rate from ground deposition of fission products does not exceed 72 R/Hr at the Control Point exits one hour after an accident. Table 5.7 of XE-1 SER - Phase II gives a dose rate of 210 R/Hr at the Control Point exit one hour after an accident based on an inventory of 5.6×10^5 MW-Secs with ground level release, lapse conditions, 12 miles/hr wind velocity, and a deposition velocity of 1 CM/Sec. If lapse conditions and the same deposition velocity are assumed to prevail, the approximate dose rate from ground deposition at the Control Point exit is inversely proportional to the wind velocity (See P.5-18 of XE-SAR, NJD-9) and directly proportional to the fission product inventory applicable to the accident. Then

D equals KI/U

Where D equals dose rate, R/Hr

I equals applicable fission product inventory expressed in equivalent reactor operation, MW-Secs

U equals wind velocity, miles/hour

and from the above noted accident analysis

$K \text{ equals } 210 \times 12 / 560000 \text{ equals } 0.0045$

and for a dose rate of 72 R/Hr

$I/U \text{ equals } D/K \text{ equals } 72 / 0.0045 \text{ equals } 16,000$

Therefore, if the ratio I/U exceeds 16,000, engine testing is not permitted with the wind directed from the test stand toward the Control Point Building. Consistent with Section 5.2.3 of the XE-SER - Phase II, the fission product inventory applicable to the accident is the residual inventory, plus the inventory generated in normal operation, plus 8,000 MW-Sec.

EXHAUST PLUME HEATING

Modifications to the ETS-1 Test Stand coolant system gives the stand greatly added protection against plume heating. The duct vault inerting door spray cooling system was completely redesigned to give complete water coverage to all exposed surfaces. An additional spray system was added to protect the heat shield and weather doors. Additionally, critical items within the test stand have been rendered more heat resistant (e.g., the use of Atlas zipper tubing on the control cabling in the shield area).

Water flow tests of the stand coolant system were conducted on February 27, 1969. During those tests, the system performed satisfactorily and complete water coverage of all exposed areas was noted.

Conservative calculations evaluating the heating effect of direct flame impingement on the stand show that overheating will not occur when a continuous water film is maintained. The following basic conditions were used for the calculations.

- A. On-stand wind at 35 MPH
- B. Steam generator system not operating
- C. Cooldown test mode
- D. Duct flowing 5 and 3 lb/sec of hydrogen and nitrogen, respectively
- E. Duct coolant (and test stand cooling system) flowing water at
7,500-8,000 GPM

An impingement heat flux of approximately 0.5 BTU/FT² sec was computed. This thermal load is from 1/3 to 1/6 of that calculated for thermal radiation from the plume during XE full power operations. Since the full-power predicted maximum temperature of the water film on the duct vault inerting wall is about 155 degrees F (a rise of about 45 degrees), it is apparent that the lower impingement thermal load will not overheat the wall when a continuous water film is maintained. As noted above, the tests of the spray system have indicated that complete coverage is achieved.