GI-148, 1746 Reference 12p (1746)

July 22, 1999

MEMORANDUM TO: Ashok C. Thadani, Director
Office of Nuclear Regulatory Research

FROM: Thomas L. King, Director
Division of Risk Analysis and Applications
Office of Nuclear Regulatory Research

SUBJECT: STAFF REVIEW GUIDANCE FOR GENERIC SAFETY ISSUE (GSI) 148, "SMOKE CONTROL AND MANUAL FIRE-FIGHTING EFFECTIVENESS"

The prioritization of Generic Safety Issue 148 resulted in its classification as a "Licensing Issue." The safety significance was deemed likely to vary greatly from plant to plant and it appears unlikely that any cost-effective generic resolution could be identified. Thus, the staff recommended that plant-specific reviews be performed to evaluate the significance of this issue. Such reviews are currently included as part of the IPEEE program, and the procedural guidance related to this issue is briefly described in NUREG-1407, which was issued in June 1991. The resolution of GSI-148 also requires the development of staff review guidance for the IPEEE submittals related to smoke control and manual fire-fighting effectiveness.

Attached for your information is the review guidance developed for GSI-148, which has been incorporated into the overall review guidance document for the IPEEE. This guidance discusses the staff review and documentation (via SERs) to permit plant-specific closure of this issue.

Accordingly, GSI-148 can be closed. That is, no further generic action is necessary, although plant-specific reviews remain to be completed via the IPEEE reviews and SER documentation. By copy of this memorandum, ACRS is being informed of our actions on this issue.

Attachment: As stated

cc: J. Larkins, ACRS

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REVIEW GUIDANCE FOR GENERIC ISSUE 148, "SMOKE CONTROL AND MANUAL FIRE-FIGHTING EFFECTIVENESS"[1]

1. Introduction

The Fire Risk Scoping Study (NUREG/CR-5088, Ref. 1) was initiated in 1987 in order to (1) identify fire risk issues that were not previously addressed in the fire probabilistic risk assessment (PRA) context, (2) provide initial assessment of the potential impact of these identified unaddressed issues, and (3) identify areas in need of further investigation. These issues represented aspects of the fire hazard which were perceived to be potentially significant contributors to fire-induced core damage frequency estimates, and had been identified after the performance of existing plant fire risk assessments. This issue, generic issue (GI) 148, was raised in SECY-89-170 (Ref. 2) concerning the effectiveness of manual fire-fighting in the presence of smoke. This concern arose as a result of studying the existing fire protection practices for control rooms, remote shutdown areas, control transfer areas, and local control areas.

In general, lubricating oils and cable insulation are the primary fire sources found in nuclear power plants. Both of these sources represent the most prolific smoke generating fuel. Experimental evidence indicates that burning such fuels in a typical nuclear power plant enclosure would obscure the entire enclosure in about 10 minutes (Ref. 3). In actual experience, fire fighters have had difficulty in seeing the fire source because of smoke (Browns Ferry, 1975) and equipment is known to have failed in smoke-filled environments.

The prioritization of GI-148 resulted in its classification as a "Licensing Issue" (Ref. 4). The safety significance is likely to vary greatly from plant to plant and it appears unlikely that any cost-effective generic resolution could be identified. Thus, plant-specific reviews would be required. Such reviews were already requested as part of the IPEEE Program (Ref. 5), and the procedural guidance to licensees for performing such an examination is provided in NUREG-1407 (Ref. 6). This review guidance was developed specifically for the IPEEE submittal review dealing with GI-148.

2. Potential Safety Significance

Smoke can impact plant risk in several ways:

(1) Smoke can reduce manual fire-fighting effectiveness, cause misdirected suppression efforts, and subsequently damage equipment not directly involved in the fire.

(2) Electronic equipment can be damaged or degraded by smoke resulting in functional loss or spurious response. Very little experimental data on equipment response in smoke environments is available, however, and the methodology for including smoke in PRAs has not been adequately developed. Additional research efforts are required to fully address the risk impact of smoke on safety-related systems.

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[1]Extracted from (IPEEE Review Guidance, dated May 1995)

(3) Smoke can hamper an operator's ability to safely shutdown the plant by causing evacuation of control centers and subsequent reliance on backup shutdown capability. If that is the case, operator actions associated with such a transfer should be addressed in the IPEEE submittal.

(4) Smoke can initiate automatic fire protection systems in areas away from the fire, potentially damaging safety systems and components. (This item was addressed separately in Generic Safety Issue 57, "Effects of Fire Protection System Actuation on Safety-Related Equipment.")

The results of a sensitivity study (Ref. 7) indicate that the smoke could result in core damage frequencies (CDFs) in the range from 1.4×10^{-6}/year to 3.8×10^{-5}/year. In addition, the impact of misdirected suppression efforts because of smoke (or the effects of smoke directly if the equipment is susceptible) could be substantial, i.e., a CDF on the order of 10^{-3}/year, if no credit for fire suppression efforts is given.

3. Staff Review Guidance

Manual Fire-Fighting Effectiveness

An important component in the determination of the frequency of fire-induced core damage scenarios or fire hazard vulnerabilities is the ability of the plant fire brigade to respond to and extinguish fires in a timely fashion before damage can occur to plant systems and components important to safety. The submittal should clearly recognize that the brigade response time is not equal to the extinguishment time. Any risk significant fire will generate significant amounts of smoke that may hamper the firefighters' effectiveness, both by causing access problems to the affected fire zone or by causing difficulties in actually locating the fire within the zone. Further, once firefighters reach the zone, it is necessary for the firefighters to determine that their water sprays will not damage adjacent electrical equipment (not affected by the fire), and also consider whether or not a fog nozzle is required to prevent possible danger to the firefighter. In any case, a thorough walkdown of the plant and review of its fire brigade practices are necessary for a licensee to determine the probability of manual suppression in a given time frame for all critical plant areas.

Table 1 provides a listing of fire brigade response time ranges from past fire PRAs for typical critical plant areas. Figures 1 through 5 plot the probability of manual suppression versus time for five critical plant areas. These figures provide the probability of successful extinguishment of a fire for each typical room type as a function of time (measured from time of fire ignition). The reviewer should perform a comparison between the generic and plant-specific predicted times for manual suppression for critical fire scenarios.

The reviewer should also determine the following:

a. Have the fire-fighting practices been reviewed as part of the IPEEE to ascertain that in no cases would the fire-fighting effort jeopardize the separation between redundant trains? That is, could firewater damage adjacent trains of electrical equipment located near those being affected by the fire?

b. Will fighting the fire or getting to the fire cause fire barriers to be opened or breached, causing fire propagation to an adjacent compartment?

c. Is the availability of fixed manual suppression systems (e.g., CO_2 system) included in the model? Some plants employ fixed manual suppression systems which are remotely actuated from the control room. In these cases, has the potential for time delays in actuation been accounted for (e.g., are plant personnel sent to verify a fire prior to remote actuation)?

d. Has the time to locate the fire once the fire brigade has arrived on the scene been explicitly considered?

e. Has the time to extinguish or gain substantial control of the fire once it is located been explicitly considered?

REFERENCES

1. NUREG/CR-5088, "Fire Risk Scoping Study: Investigation of Nuclear Power Plant Fire Risk, Including Previously Unaddressed Issues," U.S. Nuclear Regulatory Commission, January 1989.

2. SECY-89-170, "Fire Risk Scoping Study: Summary of Results and Proposed Staff Actions," June 7, 1989.

3. NUREG/CR-4681, "Enclosure Environment Characterization Testing for the Base Line Validation of Computer Fire Simulation Codes," U.S. Nuclear Regulatory Commission, March 1987.

4. Memorandum for Z. Rosztoczy from S. Bajwa, "Generic Issue 148: Smoke Control and Manual Fire Fighting Effectiveness; Generic Issue 149: Adequacy of Fire Barriers," April 3, 1991.

5. Generic Letter No. 88-20, Supplement 4, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10 CFR 50.54(f)," U.S. NRC, June 28, 1991.

6. NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," U.S. NRC, June 1991.

7. Letter to D. Basdekas (NRC) from J. Lambright (SNL), "Generic Issue 148, 'Smoke Control and Manual Fire Fighting Effectiveness,'" March 4, 1992.

Table C.6-2 Fire Brigade Response Time Range from Past Fire PRAs for Critical Plant Areas

Area	Range (min)
Electrical Switchgear Room	16-18[2]
Cable Spreading Room	16-18[2]
Control Room	6-09[2]
Electrical Equipment Room	16-18[2]
Diesel Generator Room	13-18[2]
Auxiliary Building Hallway	6-12[1]

(1) NUREG/CR-6143
(2) NUREG/CR-4832

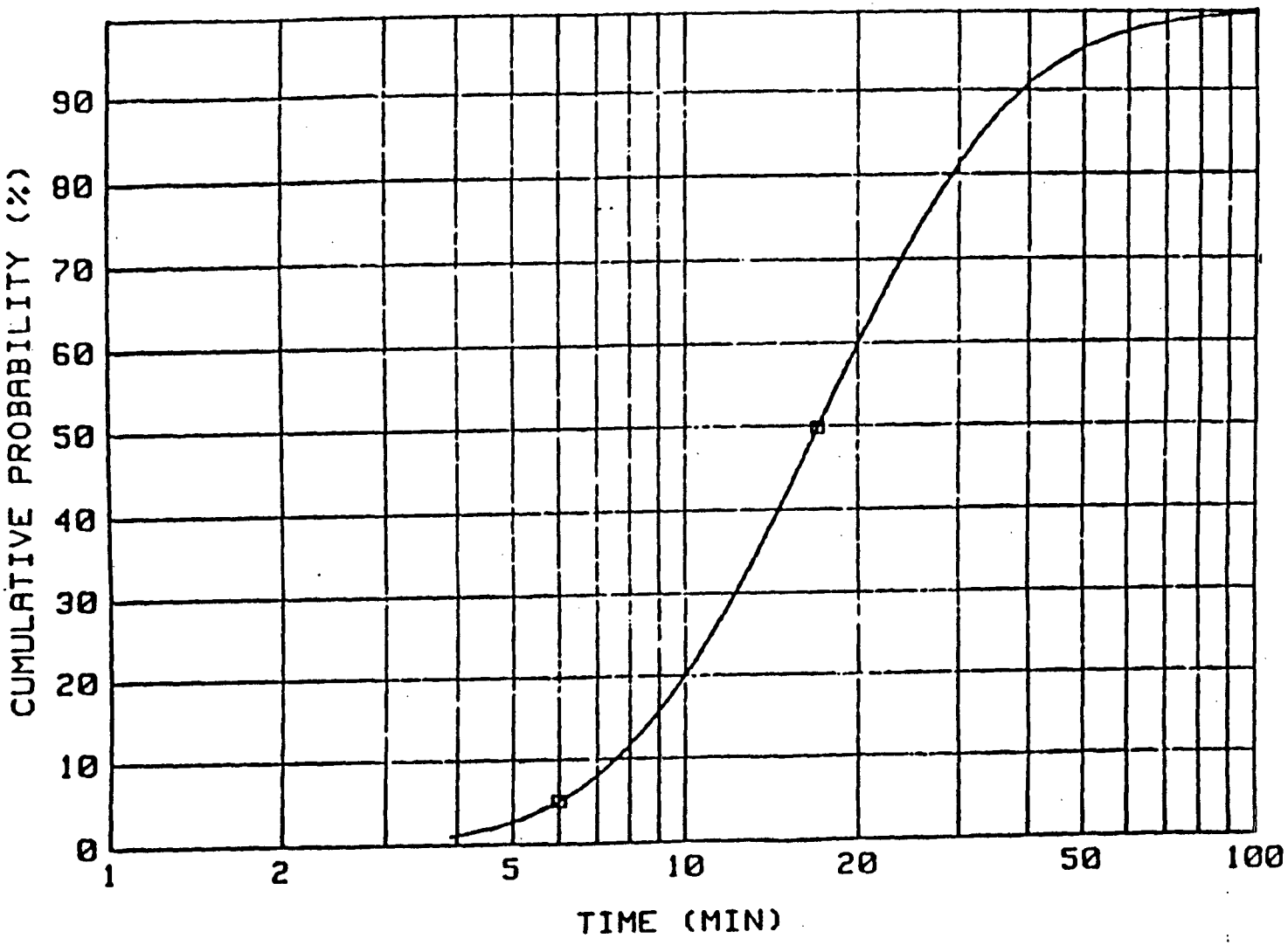

Figure 1 Typical Probability of Manual Suppression - Essential Switchgear Room

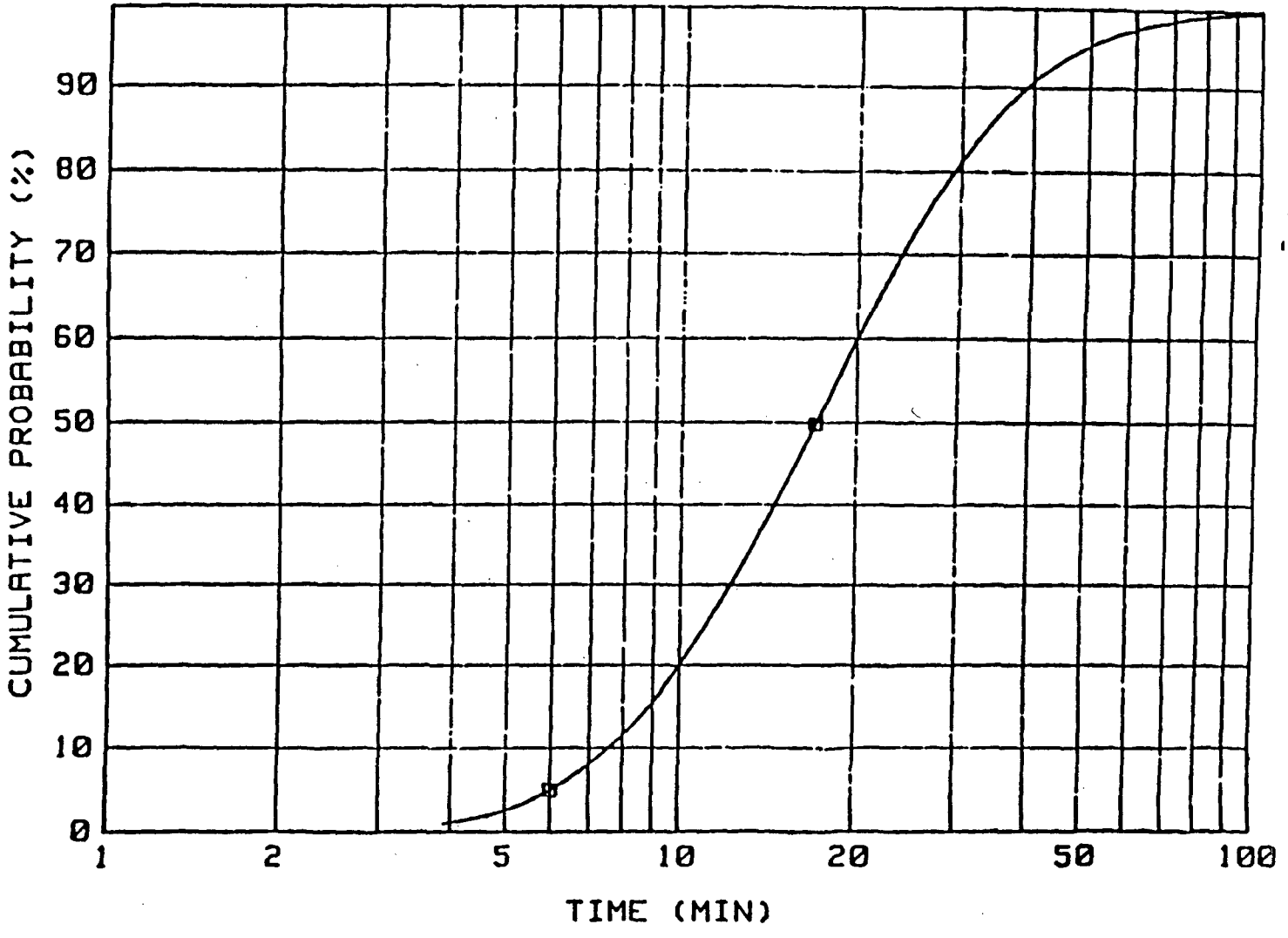

Figure 2 Typical Probability of Manual Suppression - Cable Spreading Room

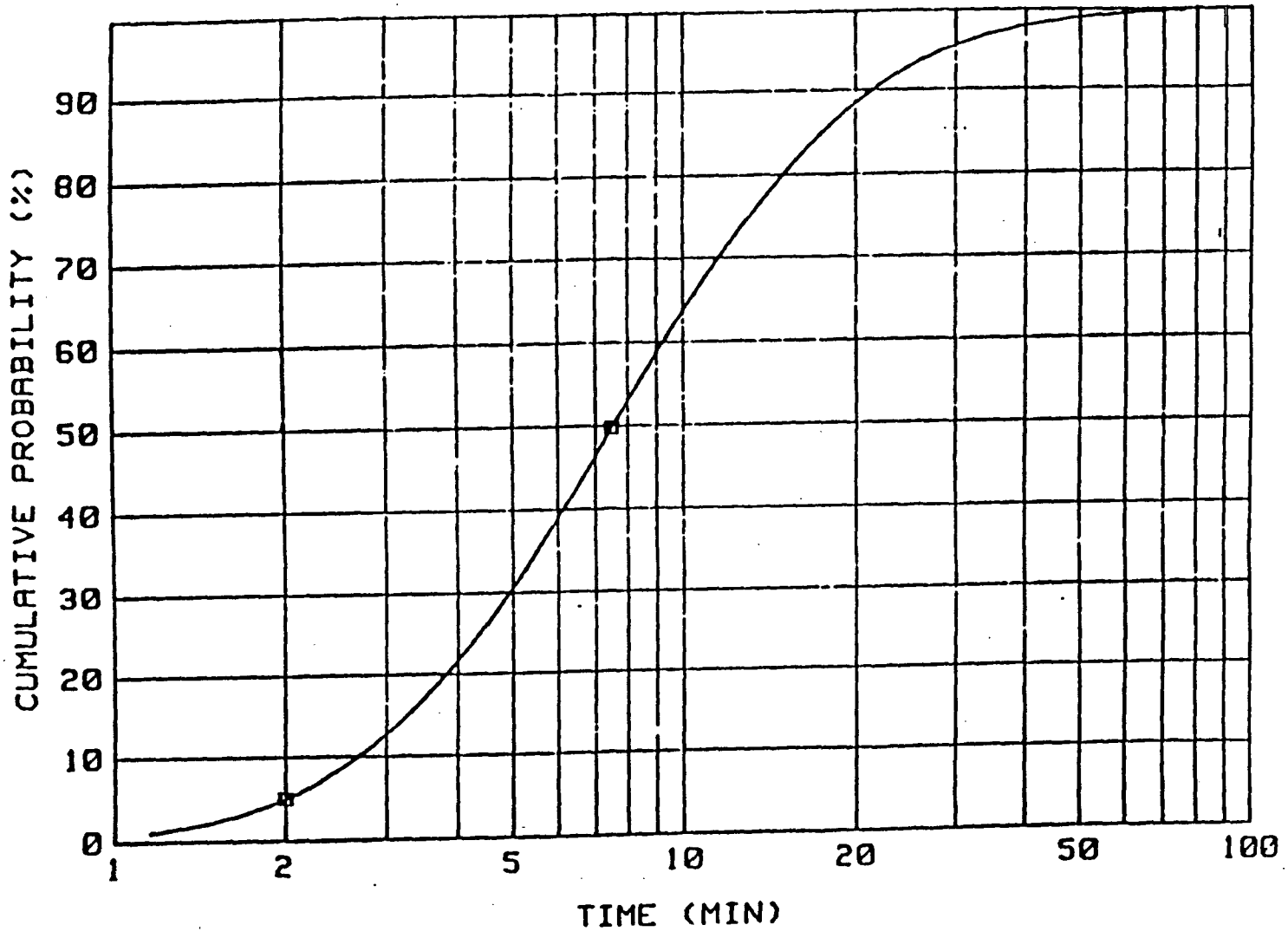

Figure 3 Typical Probability of Manual Suppression - Control Room

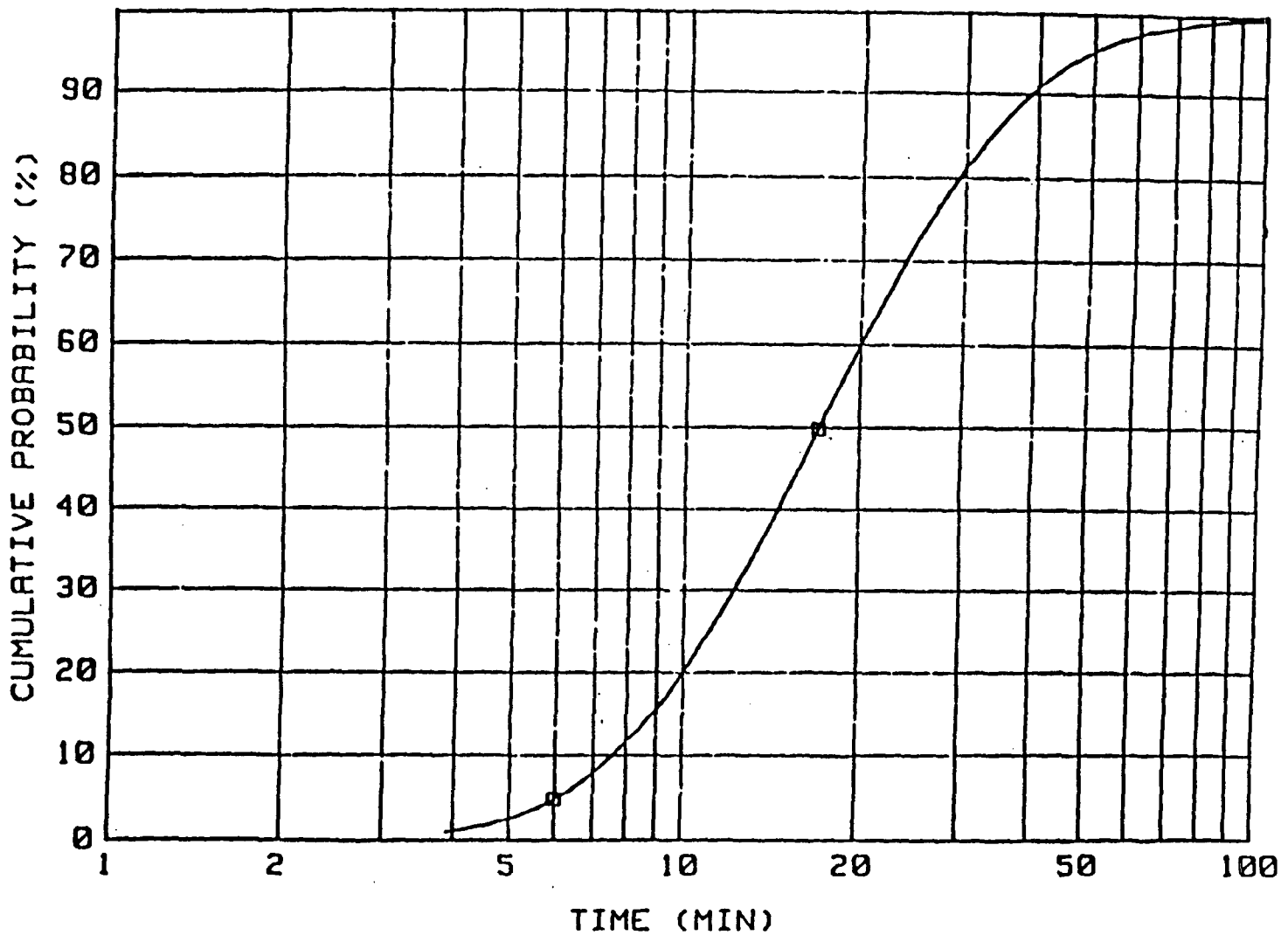

Figure 4 Typical Probability of Manual Suppression - Electric Equipment Room

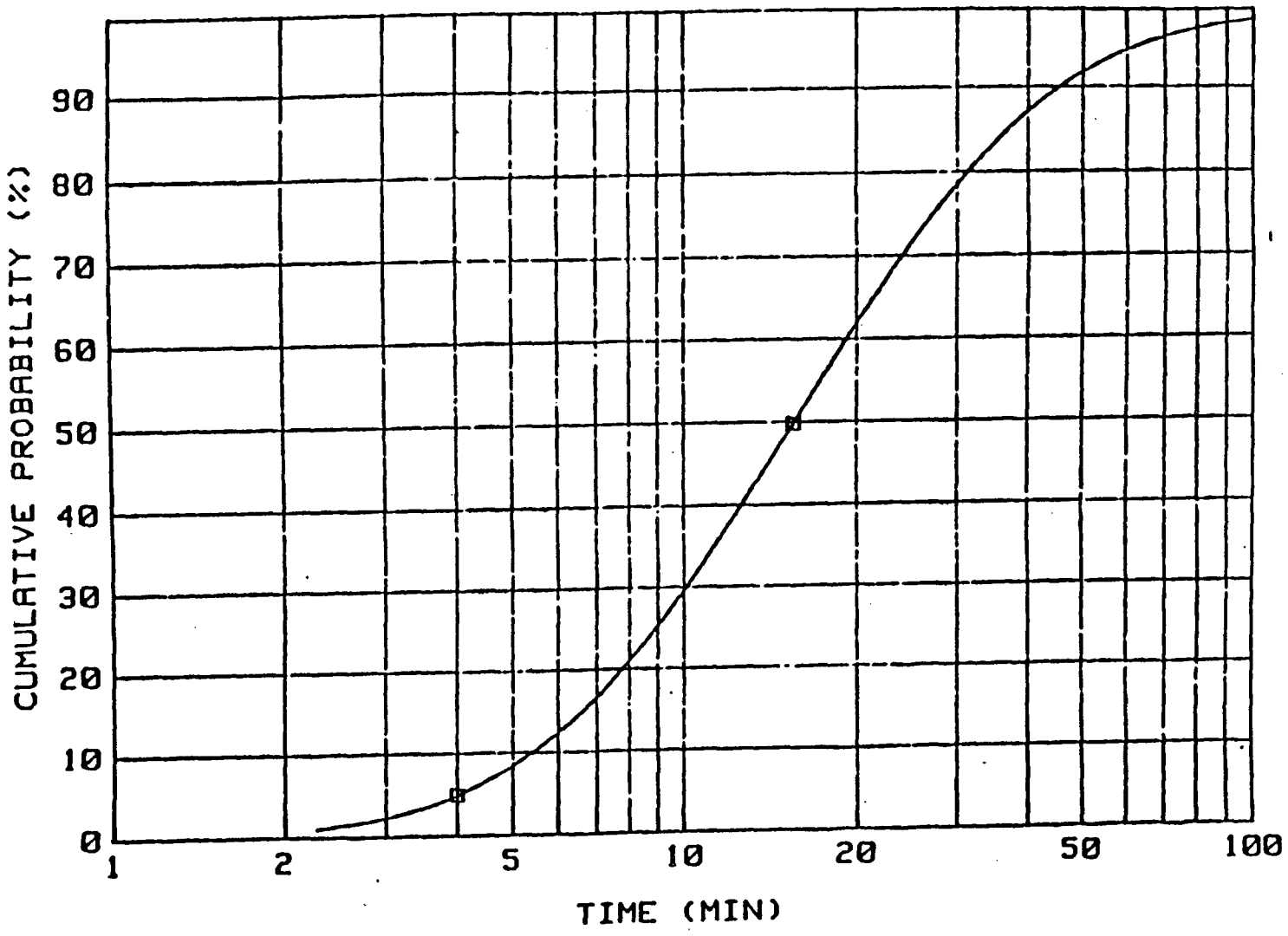

Figure 5 Typical Probability of Manual Suppression - Diesel Generator Rooms