PDR
50-280
281
334
338
339
412
423

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 14 1985

MEMORANDUM FOR: Ronald R. Bellamy, Chief
Emergency Preparedness, and Radiological Protection Branch, RI

Douglas M. Collins, Chief
Emergency Preparedness and Radiological Protection Branch, RII

FROM: LeMoine J. Cunningham, Chief
Section 2
Operating Reactor Programs Branch
Division of Inspection Programs
Office of Inspection and Enforcement

SUBJECT: BREATHING APPARATUS FOR ENTRY INTO SUBATMOSPHERIC CONTAINMENTS

Several inquiries have been made recently regarding proper breathing apparatus for routine and emergency entries into reduced pressure containments. Those facilities having subatmospheric containments (Surry 1 and 2, Beaver Valley 1 and 2, North Anna 1 and 2 and Millstone 3) present an oxygen deficient atmosphere for those persons entering them. Pressure in these containments is maintained at some value greater than 9-12 psia depending on plant operating parameters. The air inside containment has the same percentage of oxygen as normal breathing air, approximately 20%, but the reduced pressure results in reduced oxygen partial pressure equivalent to breathing air at an altitude of 14,000 ft. (Pilots are required to use oxygen at altitudes in excess of 10,000 feet.) Physiological symptoms at this level of oxygen deficiency include impaired mental acuity, reduced emotional stability, and impaired visual acuity. The degree of incapacitation would vary depending on physical fitness of the individual, and workplace stresses, such as heat and humidity, workrates, work duration etc.

In addition, other factors that could lead to oxygen deficiency in "normal" containments at atmospheric pressures such as oxygen displacement by inert gases, depletion of oxygen from combustion processes etc., become a much greater threat in reduced pressure containments since small decreases in the percent oxygen could place the individual in an environment with low enough oxygen partial pressures to cause immediate incapacitation. Under no circumstances should routine or emergency type entries be made into subatmospheric containments without breathing apparatus that provides an oxygen enriched supply of breathing air.

8503220116 XA

I am enclosing a discussion of choices and limitations of available breathing apparatus for use in oxygen deficient environments. Please contact L. Hendricks of my staff if you have any questions (492-9728).

LeMoine J. Cunningham, Chief
Section 2
Operating Reactors Programs Branch
Division of Inspection Programs
Office of Inspection and Enforcement

Enclosures:
1. Discussion
2. Los Alamos NUREG Report

cc w/number one enclosure only:
J. Wiggington, IE
R. Pedersen, IE
D. Allison, IE
R. Baer, IE
R. Neel, RES
R. Alexander, RES
R. Serbu, NRR
O. Lynch, NRR
D. Notley, RES
C. Paperiello, RIII
R. Hall, RIV
F. Wenslawski, RV
J. Montgomery, RV
J. Huang, NRR

DISTRIBUTION:
DCS 016
ORPB Reading
DIP Reading
RHVollmer, IE
JGPartlow, IE
PMcKee, IE
LJCunningham, IE
LHendricks, IE

LJC

IE:ORPB IE:ORPB
LHendricks:mlr LJCunningham

DISCUSSION OF BREATHING APPARATUS FOR ENTRY INTO REDUCED PRESSURE CONTAINMENTS

Two types of breathing apparatus provide the wearer with an independent supply of breathing air -- self contained closed and open circuit types. For the open circuit type the wearer carries the full inventory of breathing gases including a large volume of nitrogen that is unnecessary for supporting respiration. Compressed air is breathed by the wearer and then vented to the atmosphere after each breath. For the closed circuit type the nitrogen component of breathing air, approximately 78%, is continually rebreathed with oxygen being added from either a compressed liquid or gaseous or chemically generated source. Due to design characteristics of closed circuit apparatus the recirculating breathing gas starts out at 40-60% oxygen enrichment and over the course of the service life may reach upwards of 80-90% oxygen enrichment. The carbon dioxide evolved during respiration is chemically "scrubbed" from the circulating gas. The advantages of the closed circuit type are; lighter weight (the wearer need not carry the large inventory of gases that are vented to the atmosphere), longer service life, and for the application in question, high oxygen enrichmen[illegible] the air. The disadvantages are: contaminants are recirculated [illegible] they leak into the system, any induced leaks in the system would quickly exhaust the small compressed oxygen bottles, and an increased fire hazard to the wearer exists.

Listed below is a discussion of 3 types of breathing apparatus that are being used by licensees or being considered for routine or emergency entry into reduced pressure containments.

I. Negative-Pressure Closed-Circuit

Due to the negative pressure created during a large fraction of the inhalation portion of the breathing cycle, the protection provided by this class of breathing apparatus is low. This is reflected by the assignment of a protection factor of only 50 to this category of breathing apparatus (Appendix A, 10 CFR Part 20). With a protection factor of only 50 use of this device is acceptable only for routine entries where contaminant concentrations are known and peak concentrations do not exceed 50 times MPC (see footnotes k and l to Appendix A to 10 CFR Part 20). The attached NUREG/CR report prepared by Los Alamos describes principles of operation of available equipment (both negative and positive pressure types) and results of studies performed on the protection provided by these devices to a group of test subjects. Note: For this type of apparatus or any other type chosen, consideration must be given to the effect of the reduced atmospheric pressure on the operation of the equipment. A written engineering evaluation and assurance of proper operation under reduced pressure conditions should be sought from the manufacturer of the equipment.

II. Positive Pressure Closed Circuit

Although NIOSH does not have a different certification schedule for positive pressure closed circuit equipment (all closed circuit equipment is certified under the closed circuit negative pressure schedule), NRC recognizes the better protection provided in allowing their use for entry in emergency situations into environments with unknown concentrations of contaminants (see footnotes k and 1, Appendix A to Part 20). Closed circuit positive pressure type of breathing apparatus should be chosen only if open circuit positive pressure equipment cannot meet the use requirements (such as longer service life). This is reflected in NRC's assignment of a protection factor of 5000 for positive pressure, closed circuit versus 10,000 for positive pressure open circuit apparatus (Appendix A to Part 20). There is only one device available in this category today -- a one-hour device, the BioPak 60P manufactured by Rexnord Company. It is our understanding that another device will be available in the fall of 1985 -- the Draeger BG-174AP, a three-hour device that also exhibits positive pressure characteristics. A written engineering evaluation and assurance of proper operation under reduced pressure conditions should be sought from the manufacturer of the equipment. A concern exists in firefighting applications with this type of equipment since the positive pressure causes outward leakage of highly oxygen enriched air. The total volume leaked is small and would be expected to cause a hazard only in the immediate environment of the wearer's facepiece. Draeger recommends against using their equipment for firefighting. The BioPak 60P comes equipped with a special shield/hood for firefighting that covers the facepiece, head and neck, and allows dilution of oxygen rich gas leaking out around the facepiece.

III. Positive Pressure Open Circuit

Due to the concerns mentioned in number II, above, for use of positive pressure closed circuit apparatus in firefighting applications, licensees are considering a group application to NRC for an exemption to Part 20 to use one-hour open circuit equipment in a manner that voids the NIOSH approval of the device-- enriching the compressed air to 35% oxygen. 20.103 (e) specifically provides for an exemption based on reliable test data in those cases where NIOSH approved equipment is not available for use. It appears that these devices used in this manner are not likely to be certified by NIOSH because of the very limited application for their use. At least one manufacturer is performing tests and engineering analyses on the effect of 35% oxygen enriched air on their equipment's operation. Licensees would need to demonstrate to NRC that strict procedural controls existed to ensure the correct percent oxygen enrichment of the air and that any other special maintenance or use procedures identified by the equipment manufacturers were strictly adhered to. Because the reduction in ignition temperature between 20% and 40% oxygen enrichment is greater than subsequent reductions between 40-100% oxygen enrichment, a potential fire hazard may still exist with open circuit devices using 35% oxygen enriched compressed air. However, the fire hazard should be counter-balanced to some extent by the reduced pressure environment (see NFPA Fire Protection Handbook, fourteenth edition).