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SUMMARY OF FINAL REPORT

Determination of Shelter Configuration
for Ventilation

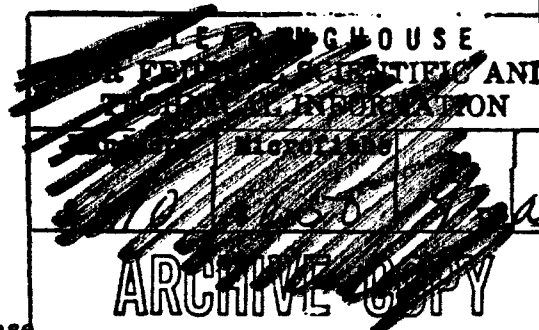
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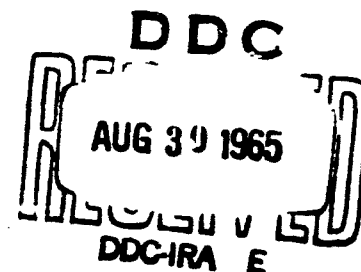
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OCD Work Unit 1235A

Determination of Shelter Configuration
for Ventilation

by

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Summary of Final Report

I. THE NFSS

In Phase 1 of the National Fallout Shelter Survey (NFSS), all buildings in the United States, except single family dwellings, thought to have a protection factor (PF) of 20 or more and space to shelter 50 or more people were surveyed. This was done by Architectural-Engineering (AE) firms under contract to the Army Corps of Engineers or Navy Bureau of Yards and Docks to determine the current capabilities and capacities of structures as shelter from radioactive fallout. Through these efforts approximately 375,000 individual facilities were surveyed and about 119 million spaces affording a protection factor of 40 or better were located [Reference 1].

Based on the results of the Phase 1 survey, contractors subsequently in Phase 2 of the NFSS evaluated designated facilities to determine the feasibility and cost of: (1) increasing shielding to provide a prescribed minimum protection factor; (2) improving habitability to meet minimum specifications; and (3) increasing shelter capacity. Shelters deemed acceptable also were marked with fallout shelter signs in Phase 2. Approximately 73 million shelter spaces had been marked by April, 1965 [Reference 2].

Facilities indicated in Phase 1 to provide shelter for 50 or more people, and having a protection factor in the 40 to 99 range, were evaluated in Phase 2 to determine if it were feasible from engineering and structural standpoints to make shielding improvements to bring the protection factor up to at least 100. It was also the responsibility of the contracting AE firm to estimate the cost of such modifications and to compute the number of acceptable spaces that could be added through shielding improvements.

To be habitable, shelters within the facilities under consideration in Phase 2 of the NFSS had to meet the following specifications [Reference 3]:

1. Floor Area: At least 10 square feet of net shelter space per person.
2. Headroom: A minimum of 6½ feet for at least 50 percent of the occupants and not less than 4 feet for the remainder.
3. Ventilation: Three cfm/person of fresh air.
4. Lighting: Two foot-candles at floor level.

In all shelters where there was an inadequate amount of incoming fresh air or the shelter was of such construction that re-circulation of air was below the minimum requirements, the contractor was required to estimate the costs and feasibility of providing outlets, exhaust ducts, and adequate filters to bring each shelter under survey up to a habitable level. In Phase 1 of the NFSS the capacity of the shelters considered to have inadequate ventilation was calculated on the basis of up to 500 cubic feet/person rather than 10 square feet/person. Shelters of this type were normally in stories above ground in windowless structures or in stories below ground level. In Phase 2 the AE firms computed the additional spaces which could be provided if all shelters that were presently deficient on the basis of inadequate ventilation could be adequately ventilated and, consequently, their capacities could be determined on the basis of 10 square feet/person. These additional spaces which can be added through ventilation improvements are referred to as "spaces added."

II. THE PROBLEM

Phase 2 of the NFSS indicated that about 50 million fallout shelter spaces could be added to the national inventory of spaces just by an improvement of ventilation in existing shelters which were indicated to afford a protection factor of 40 or more.

Although a great deal of data pertaining to the ventilation problem was generated from Phase 2 efforts, not all of the data relevant to the problems of ventilator design were obtained. In fact, such critical determinants as data on how shelters are currently partitioned, the distribution of the number of rooms within shelters according to size, the size of outside apertures in rooms, and the proportion of rooms through which fresh air could be drawn from the outside or through which stale air could be exhausted from the shelter were not provided through the work done in Phase 2. All of these data, as well as many other types of information, serve as determinants for arriving at an estimate of the number and size of ventilators required, as well as having direct bearing on the actual design of the ventilators.

III. METHOD OF APPROACH

To assist the Office of Civil Defense in the design of Package Ventilation Kits (PVK), the Research Triangle Institute has determined the configuration of a sample of 158 facilities (surveyed in Phase 2 of the NFSS) requiring additional ventilation and analyzed data collected on these facilities. Results from this sample are adequate for making estimates on the national level; however, due to the small number of buildings in each OCD Region and the resulting large relative error, Regional estimates should not be made.

In addition to basic data necessary to specify the number, size, and type of ventilators, other data necessary to determine appropriate locations of PVK's within shelter areas, air duct lengths, and air outlets were collected. Pertinent portions of these data are summarized throughout this report. Data for each sample facility surveyed were previously sent to OCD in the form of an individual data collection form, together with detailed plan view sketches.

Also included in this report are tables describing certain characteristics related to shelter use. These data, though not a part of the primary task of providing information necessary for the design of a ventilator, will provide some insight to those engaged in operational planning. Included in this group of data is information on structural characteristics, NFSS and non-NFSS food and medical supply locations, the availability and accessibility of telephones, radios, water, fire fighting equipment, and bedding materials, and an appraisal of how well the shelter area could be adapted to allow sleeping, to isolate the sick, and to provide toilet facilities.

IV. SUMMARY OF FINDINGS RELATED TO VENTILATION

According to data available from OCD in June 1964, it is estimated that there are 138,000 facilities that require ventilation improvements in the universe of 216 SMSA's. Based on the statistical sample of facilities surveyed, it is estimated that these facilities have a potential for adding a total of 55 million shelter spaces through ventilation improvements; when added to the existing spaces in stories requiring ventilation, this gives a total of 66 million spaces. These facilities are estimated to contain over 1 million chambers (rooms) requiring ventilation. In an estimated 22 percent of these facilities, no chambers in the shelter area requiring ventilation have exterior walls with apertures, while 18 percent of them have exterior walls with apertures in all chambers in stories requiring ventilation. It is estimated that 32 percent of all shelter stories requiring ventilation are of a basic single room type. Also, it is estimated that 84 percent of all shelter spaces added through ventilation improvements are in basements or sub-basements.

Data gathered by RTI indicate that approximately 38 percent of the facilities have less than 100 spaces added, that 82 percent have less than 500 spaces added, and that virtually none have more than 10,000 spaces added.

About 7 percent of the spaces added are in facilities with less than 100 spaces added and 36 percent are in facilities with less than 500 spaces added; therefore, about 64 percent are in facilities with more than 500 spaces added.

The median number of chambers (rooms) in a facility is between 3 and 4 and the majority of the chambers (73 percent) have a shelter capacity of less than 50 people on a ten-square-foot-per-person basis. Only about 4 percent of the chambers have a capacity of more than 200 people, but they contain approximately 45 percent of the total spaces.

Various cumulative frequency distributions are plotted in this report, giving

tribution of apertures and aperture area in the facility and in the individual
rs. Numerous conclusions can be derived from these curves. For example:

- (1) About half of the facilities having exterior walls with apertures (in stories requiring ventilation) are estimated to have more than one aperture per 350 square feet of usable shelter area, and very few facilities have one or more apertures per 100 square feet of usable shelter area;
- (2) Almost half of all facilities with spaces added have 3 or more square feet of aperture per 100 square feet of usable shelter area, and virtually no facilities with spaces added have more than 20 square feet of aperture per 100 square feet of usable shelter area;
- (3) Of the chambers having exterior walls with apertures, most have between one and 10 apertures per 1,000 square feet of total chamber area;
- (4) Of these same chambers, most have between 1 and 30 square feet of aperture per 100 square feet of total chamber area.

An important result derived from the data is that of the 55 million spaces that
added through ventilation improvements, only 20 million are located in SMSA's
they are needed to shelter the population of the SMSA in which they are
and if all identified spaces are used. The remaining 35 million spaces are in
such that either:

- (1) There are sufficient existing spaces for the SMSA population (in which case some existing spaces and all of the spaces added through ventilation may not be needed), or
- (2) there are not sufficient existing spaces for the SMSA population but not all of the spaces added through ventilation may be needed to provide complete coverage.

Based on April 1965 information, 53 percent of the located facilities have been
used, 57 percent have been marked, and 39 percent have been stocked [Reference 2].
Throughout this report the term "existing spaces" is used interchangeably with the
"identified spaces."

REFERENCES

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3. Office of the Chief of Engineers. Phase 2 Fallout Shelter Survey Instructions. Washington: Office of the Chief of Engineers, U. S. Army Corps of Engineers, 15 March 1962.