BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

Upton, New York 11973

Department of Nuclear Energy

(516) 345- 2144

August 11, 1980

Mr. Patrick Sears
Chemical Engineering
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

THIS DOCUMENT CONTAINS POOR QUALITY PAGES

Dear Pat:

Recently there have been numerous discussions regarding the value of applying a realistic pressure gradient across sample penetration seals during the performance of the ASTM-E 119 fire qualification test. Dr. Boccio, Mr. MacDougall, Mr. Smith and myself have again reviewed the pertinent technical questions and offer the following statements regarding the potential safety significance of dismissing the anticipated pressure rise due to a fire during a proof test. To help claifry our recommendations, attached is a letter dated May 5, 1980 to R.L. Ferguson and a Brookhaven National Laboratory (BNL) memorandum dated June 25, 1980.

On the outset of this discussion I will break the question down to two subsets. First, given various expected fire sizes and growth rates, what pressure rise, if any, can be expected? This gradient is dependent on fire properties, room size, room ventilation, available heat sinks, and burn duration. The second is, once a time rate of change of vault pressure is established, will it be expected to adversely affect the performance of the specific penetration seal design? Much to my regret, at this time, neither of the questions can be satisfactorily answered with adequate engineering certainty. The sparseness of conclusive test data and the associated difficulties with quick analytical approaches forces the reviewer to rely on "engineering judgement." When one polls the profession, in a limited fashion, (i.e. mechanical and fire protection engineers) the results are inconclusive. In general, it is our conclusion that the industry recognizes the problem but has not as of yet identified the methods to handle it. This is represented by the foreward of the IEEE Std. 634-1978. It is also our understanding that a recent meeting of the E5 working committee of the ASTM did not dismiss with "finality" the need of considering pressure buildup in windowless structures, but instead, as with the IEEE, simply held off on a final conclusion due to lack of data. This conclusion is based on our discussions with Mr. B. Cohn and J. Campbell of Gage Babcock.

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When reviewing the industries guides, we must keep in mind that to change an existing general fire standard, we must proceed with caution. The application of a pressure gradient, for example, could necessitate a redesign of standard equipment such as fire doors, since in fact there is a high potential that they could not pass such a new test. Therefore, I agree with the

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various standards' committees in there hesitation to move quickly into the general application. However, in the case of a penetration seal in a nuclear power plant, the application moves from the general to very specific. The propagation of hot by-products of combustion through a fire door might not be severe since one would not expect to have combustibles immediately adjacent to it; whereas, a penetration not only has combustibles on each side but also through the core of the seal. The specific applications are quite different. Additionally past fire standards have been generically developed with life safety or property damage limitations as a goal. Our concerns deviate from this in that core integrity and societal risk reduction are of principle consideration. Component designs in each case are not necessarily the same; and, therefore, specific proof tests could be expected to deviate.

In various discussions I have heard statements that to apply a pressure gradient in a penetration seal test is "beyond the state-of-the-art." This I disagree with. Duke Power has already completed several E-119 tests with pressure consideration and is planning additional ones this fall. It should be noted that apparently some of these internal company tests, not available to BNL, indicate seal degradation with involved side relative pressure rise. TVA is another licensee that has conducted tests. Also, recent tests (see article by P.C. Atwood in Fire Technology, February 1980) involving penetration of plastic DWV pipe have shown significant reduction in resistance when vertical pipe was housed in vented chases as compared to nonvented chases. With furnace pressure maintained at only 0.2 in WG, the factor influencing the outcome of these tests was reported to be the pressure within the chase. If the chase was vented to ambient, then a pressure gradient was established between the chase and the furnace resulting in failure. With no means for venting, hot gases driven into the chase were minimized resulting in increased resistance time. In addition, it is my understanding that Sandia, under contract to NRC, is planning confirmatory experiments in the area to begin this fall. Dr. Boccio has been in contact with Sandia investigators to collaborate on initial and boundary conditions in a hope to resolve some of the many unknowns.

To return briefly to the initial two questions at hand, BNL has conducted a limited analysis of the pressure buildup expected using the E-119 time temperature curve as a starting point in a prescribed room size. This calculation, although conservative since we have not devoted enough time to develop adequate heat sinking effects, shows the potential for inches of water increase over normal ambient conditions during a three hour fire. If this is correct, in an order of magnitude analysis, questions will arise regarding the now marginally acceptable penetration seals, the potential for thermal convective penetration of porous seals and, in some cases, structural integrity of the seal.

In a recent letter to Mr. Parks, of Underwriters Laboratories, Dr. R. Brady Williamson, of the University of California, Berkeley, expresses similar concerns regarding the need for today's testing to include a pressure gradient. In this letter, reference attached, Dr. Williamson concludes that .05 inches of water is a good approximation and states that this relatively low gradient could change the results of the test. We agree with Dr. Williamson's arguments and would add the fact that in the windowless vault, like structures of a nuclear power plant, one could expect much larger pressure differences.

Since the fire protection program is chartered to audit the nuclear industry and thus, will not typically review each specific seal design in the future, the importance of a qualification test that identifies all marginal seals is underscored. I recommend that the NRC utilize the interim pressure gradient proposed in my May 5, 1980 letter and take an active role in supporting future ASTM and IEEE standards' activities. With all the discussion and proposed work in this area, a optimum engineering decision should be able to be made in the near future.

Respectfully yours,

Robert E. Hall, Group Leader
Reactor Engineering Analysis

REH:sd
attachment
cc.: R. Ferguson w/att.
G. Harrison "
M. Levine "
V. Benaroya "
S. Hudson "

BROOKHAVEN NATIONAL LABORATORY

MEMORANDUM

DATE: June 25, 1980

TO: R.E. Hall

FROM: R.O. Smith and E.A. MacDougall

SUBJECT: Trip Report - Meeting at Duke Power Company, Charlotte, NC

On Thursday, June 5, 1980. two members of the BNL staff, E.A. MacDougall and R.O. Smith met with Thamir Al-Hussaini and Paul McBride of Duke Power's design engineering department and Doug Brandes, a fire protection engineer in the design engineering department. The meeting was held in the Duke Power Company offices on South Church Street in Charlotte, North Carolina. The subject of the meeting was the penetration fire testing performed by the utility and particularly the application of a differential pressure across the penetration during the testing.

During our investigation of the desireability of performing penetration fire testing with a differential pressure, it became evident that most of this testing had been done at the Southwest Research Institute in San Antonio, Texas. It now apears that all of this Δp testing was performed at Southwest under contract to Duke Power. Our attempts to review the data resulting from this testing with Southwest were not successful and we turned to the Duke engineer whom we were told by Southwest was the most knowledgeable but unfortunately he was no longer with Duke. However, contact with him led to Mr. Al-Hussaini and ultimately to our meeting in Charlotte.

Duke has performed a good deal of Δp testing, both experimental at their own instigation and other to satisfy NRC concerns. The testing addressed to NRC concerns is in a Southwest Research report; we have a copy of this report. The experimental testing has not been published and will not be for what amounts to political reasons.

It appears that some of the experimental data got to NRC at one time and it cost Duke a great deal of time and money to defend a position which they felt, and still feel, was not an NRC concern because it was experimental only and not done to meet any NRC requirements.

In our discussion it became evident that the utility felt that it was a long way ahead of the rest of the industry and NRC in this area and we tend to agree with them on this point. They pointed out that the testing done was under their direction, the penetration seals were installed by Duke personnel and inspected by the Duke's quality control group to Duke design drawings.

Repairs to the penetration after replacement of cables are also the subject of design drawings and are signed off by Quality Control. The repairs have also received fire testing with differential pressure applied. In their experimental work they have tested with different Δp's to a maximum of 7", however their design point is the pressure normally in the compartment which rarely exceeds 1" of water. Duke feels definately the Δp testing should be a requirement.

They mentioned some comparative testing in which penetration seals exposed to a constant positive pressure failed whereas the same seal exposed to intermittent position pressure did not. This case was cited in our May 5 letter to NRC.

We showed them that letter after removing the listing in Appendix 1 and they had no comment other than a rewording which would not use "positive pressure." We agreed that this should be a differential pressure in the positive direction which permits ambient on the fire side and negative pressure on the unexposed side of the penetration.

They did not take any exception to our recommended position of establishing the Δp as the maximum pressure measured in the safety related areas of the plant being considered plus a 25% factor of safety.

Our letter to NRC should be revised in the area of our reference to "positive pressure."

Perhaps we should have a meeting with our fire protection engineers to establish where we go from here. The goal appears to be the establishment of a guide for Δp penetration testing. Other possible moves

- visit Jim Munson of Franklin Research Center to find out why he can't do Δp testing.
- witness next Duke Power test at Southwest Research to learn more on how they do it and what problems they have. Might need high level contact to get us in.

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COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
DIVISION OF STRUCTURAL ENGINEERING
AND STRUCTURAL MECHANICS

BERKELEY, CALIFORNIA 94720

February 11, 1980

Mr. Russ Parks, Associate Engineer
Fire Protection Department
Underwriters Laboratories
333 Pfingsten Rd.
Northbrook, Illinois 60062

RE: A Standard Test Method for Penetration Fire Stops

Dear Russ:

I was grateful for the opportunity to present my case on positive pressure at the portion of the task group which assembled at Northbrook on February 6, 1980. It is unfortunate that the group was so small. The final vote tally of 6 votes can hardly be called definitive.

I request that this letter be added to any ballot on this matter which will be circulated as a result of our task group meeting. In the following paragraphs I will summarize my letter of January 21st to the task group, and my discussion at the task group meeting.

It is well known that a fire will generate positive pressure due to the confinement offered by the walls and ceilings of an interior space. McCaffrey and Rockett[1] measured this pressure for pre-flashover fires and compared it with that expected from modelling. Earlier, Waterman[2] had measured the pressure developed in a series of full-scale fire experiments.

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[1]McCaffrey, B. J., and Rockett, J. A., "Static Pressure Measurements of Enclosure Fires," Journal of Research, Vol. 82, No. 2, National Bureau of Standards, Washington, D.C., Sept.-Oct. 1977.

[2]Waterman, Thomas E., "Shelter Habitability in Existing Buildings Under Fire Exposure," ITT Research Institute, Technology Center, Chicago, Illinois, June 1966.

These references were circulated to the task group and are available to anyone who writes me.

More recently, Fang[3] had measured the pressure differentials in a series of full-scale fire experiments which went from pre-flashover through complete burn out of rooms with ordinary residential contents. Figure 4 from that report is reproduced below to show the essential findings of the experimental process.

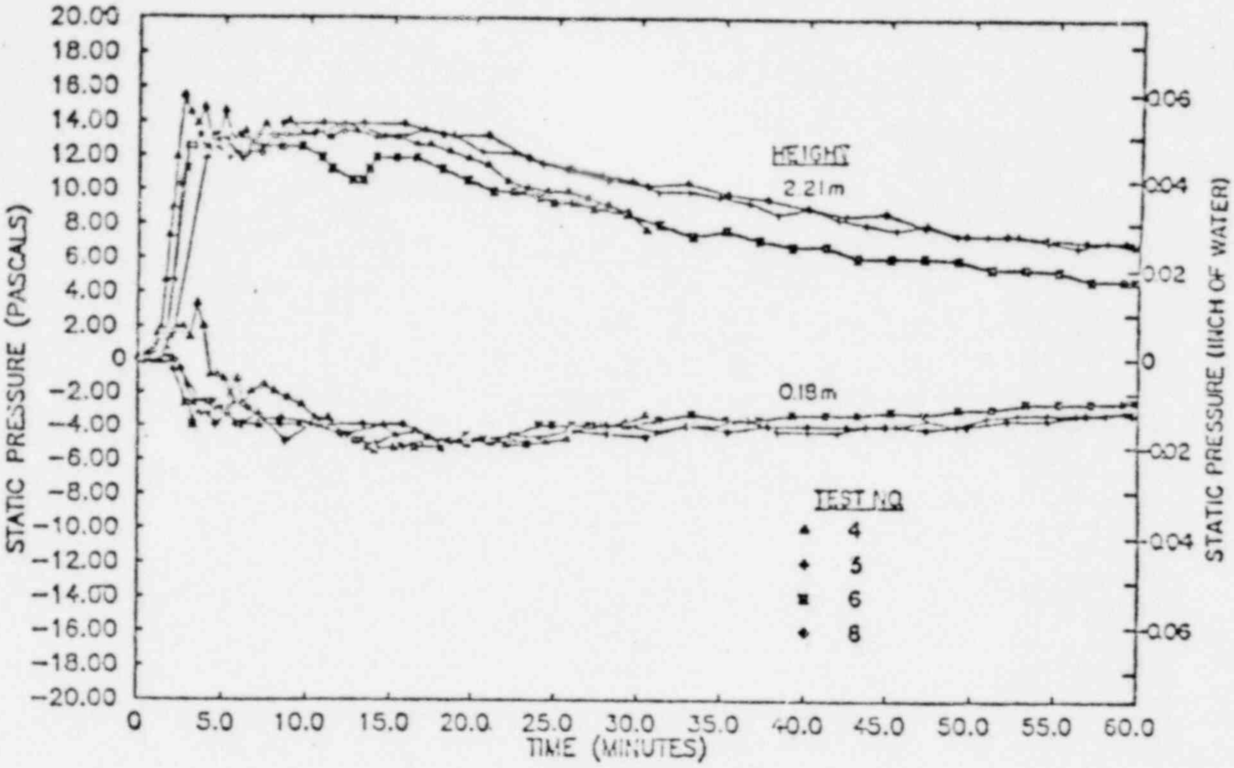

FIGURE 4: The History of Static Pressure Developed From Room Fire Tests with a Range of Fuel Loads[3]

These experiments show:

A. *There is a positive pressure developed in the upper part of the room and a negative pressure at the bottom,*

FURTHERMORE

B. *A value of 12.5 Pa (0.05 inches of water) is a good approximation for the pressure in the post-flashover portion of the fire.*

The existance of this positive pressure is well known and was clearly described by T. T. Lie in his classic book, "Fire and Buildings."[4] A copy of Section 3.3.4.2 is reproduced below. The reader should note that Lie was well aware of the implications of this discussion and our problem and thus, I have underlined the last sentence.

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[3]Fang, J. B., "Static Pressures Produced by Room Fires," Center for Fire Research, Institute for Applied Technology, National Bureau of Standards, Washington, D.C., Interim Report.

[4]Lie, T. T., Fire and Buildings, Applied Science Pub. Ltd., London, 1972.

3.3.4.2. *Pressure in a burning space.* As explained in Section 1.2, during a fire there is normally outflow of hot gases from the windows in the enclosure, above a certain level, and below this level inflow of cool air from outside into the enclosure. This means that the pressure in the enclosure is higher than the outside pressure above the neutral plane, and below this plane it is lower. Measurements during experimental fires [3.50, 3.51] show that the maximum overpressure which can be expected during a fire in an enclosure of about 3 m height is of the order of 2 mm water column. This value is in agreement with theoretically found values [3.51, 3.52]. A typical pressure distribution along the height of a window during a fire is shown in Fig. 3.11.

attached

references given below

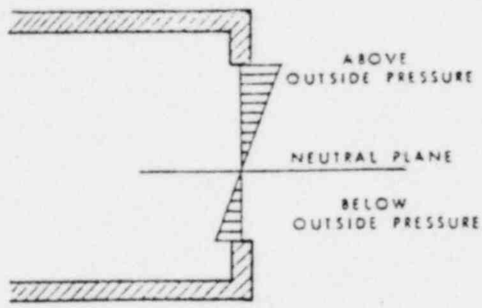

Fig. 3.11. Pressure distribution along the height of a window during a fire.

Fire testing laboratories often operate their furnaces at slightly negative pressures. This hinders smoke and gases from entering the laboratory. There is, however, also a disadvantage in maintaining a negative furnace pressure. This is caused by the fact that cool air is drawn from the laboratory into the furnace through cracks or openings in the fire separations during testing. As a consequence of the flow of cool air the behaviour of the test specimen may be significantly different from that during an actual fire, where there will normally be an outflow of hot gases through the structure from the burning space to outside. This is especially true for wooden floors and doors. Often the fire resistance of these structural elements is determined by the passage of hot gases through clearances in the elements, for instance that between the door and its frame. When there is overpressure in the furnace the burning of an opening through the element may be substantially faster than when there is underpressure owing to the flow of hot gases through the opening. From that point of view it is desirable to maintain an overpressure in fire test furnaces. In general an overpressure of about 2 mm water column will be sufficient. For test specimens which do not contain clearances and have a low porosity, such as brick, concrete, or steel, the influence of the pressure on the fire resistance of the specimen is probably small and maintaining an overpressure in the furnace is of little importance.

3.50 Kawagoe, K., "Fire Behavior in Rooms," Building Research Institute, Ministry of Construction, Report No. 27, Tokyo, 1958, 73 pp.

3.51 "Full Scale Fire Test on an Apartment House in Tokyo," Japan Housing Corporation, Tokyo, 1963, 36 pp.

3.52 McGuire, J. H., "Smoke Movement," Fire Technology, 3, 1967, 165 pp.

In the letter accompanying my negative vote on this standard I said:

"I have voted negatively on this standard for two reasons:

1) The standard test should specify a positive pressure differential in the upper half of the furnace.

2) There should be a flame source on the exposed side of the penetration device to represent the appropriate fire environment.

"I have previously made these objections, and although the standard has been substantially improved with respect to pressure, I believe the standard should be a positive pressure differential. There will always be a positive pressure differential in a post-flashover fire,[5] and the test should reflect this by requiring it. Section A3.1 of the draft standard leaves the determination to either a) code requirements, b) maximum calculated stack effect in the building, c) test sponsor, or d) special circumstances. I would argue that none of these criteria should be used to establish the pressure differential. A fire test should have its important fire characteristics well defined b, its standard version. If the pressure differential can be determined by any of the list of four, which includes the sponsor, then how is the testing laboratory going to nforce the proper fire characteristics?

Devices tested with a positive pressure differential are going to experience a more severe fire exposure than those with a negative pressure differential. This will lead to different fire performances when measured by the same standard. In my opinion, this will be confusing and misleading to everybody.

The second reason for my negative is a less well known one, but it is closely coupled to the positive pressure issue. When we have a positive pressure in the fire compartment under actual fire conditions, we also have excess pyrolyzates. This additional flame source may penetrate any openings which develop in the tested device. In standard test furnaces, however, unless there is a combustible assembly, there are no flame sources in contact with the specimen. I recommend that a flame source be placed in the furnace to bath the penetration device in a flame. This flame should extend beyond the device in all directions."

I have withdrawn the second negative reason at this time, but I intend to resubmit it if our research indicates that it is important.

The IEEE Standard 634-1978 "Cable Penetration Fire Stop Qualification Test" has not taken a stand on the positive pressure issue. It notes that "this problem is recognized" but the standard does not address it since ANSI A 2.1-1972 (ASTM-E119-1971) does not address it. The IEEE Standard comments: "This should be a future task," Well, we in ASTM Committee E-5 are the stewards of the E119, E152 and E163 fire tests and I do not think we should issue a

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[5]Babrauskas, V., and Williamson, R. B., "Post-flashover Compartment Fires: Basis of a Theoretical Model," Fire and Materials, Vol. 2, No. 2, 1978, pp. 39-53.

From T. T. Lie's, Fire and Buildings, Applied Science Pub. Ltd., London, 1972.

1.2. Burning and Decay Period

Whereas little information exists about the process of fire development during the growth period, there is a fair amount of information about the fire in the fully developed stage.

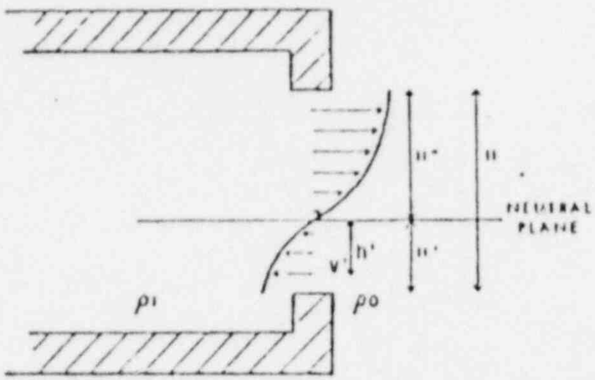

Fig. 1.2. Velocity profile at the window opening of an enclosure during fire.

During* a fire in an enclosure, heat is produced by combustion+ of the gases evolved from the materials in the enclosure. There is a difference in density between the hot gases and the cold air outside. Therefore, the lighter hot gases rise and flow** out of the enclosure at the upper part of the opening. The outflowing hot gases are replaced by cold air drawn in, which is heated in the enclosure. The air, which is necessary for combustion, normally enters the enclosure at the lower part of the opening (see Fig. 1.2).

Depending on the amount, area and spacing of the combustible materials and the dimensions of the openings in the enclosure, the rate of burning of the materials may be determined by the rate of air supply. The larger the openings the higher the rate of burning. This

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*From the earliest time this is true but it becomes more important in the latter stages.

+There is also solid-state combustion of cellulosic.

xx If possible.

is true up to the point where there is an excess of air; then the fire is no longer controlled by the dimensions of the openings. The fire is now mainly controlled by the surface area of the combustible materials which can burn at the same time. At this stage the circumstances approach those of a fire in the open [1.6, 1.7]. It is obvious that whether a fire will be ventilation controlled or not depends on the furnishings. In a building, furnishings are not equal everywhere, often differing from room to room. They change also with time. In many buildings, however, there is sufficient surface area of furnishings that it can generally be assumed that the rate of burning will be controlled by the rate of air supply. This is further explained in Section 2.1.

Normally during a fire there is a certain level at the openings, the so-called neutral plane, below which cold air flows in and above which hot gases flow out continuously. The height of this plane is of crucial importance in problems of preventing the spread of heat and smoke, as will be shown in Chapter 5. It depends mainly on the temperature of the gases and the dimensions of the openings and can be found by calculating the ratio between the quantities of outflowing combustion products and inflowing air [1.8, 1.9, 1.10].

1.2.1. *Rate of Burning*

The rate of inflowing air, which determines the rate of burning for ventilation controlled fires, can be given as

$$V' = aH'Bv_m' \qquad (1.1)$$

where (see also Fig. 1.2).

- V' — the rate of inflowing air
- a — the coefficient of discharge
- H' = height of opening under the neutral plane (see Fig. 1.2)
- B — breadth of the window
- v_m' — average velocity of the inflowing air.

If L is the volume of air that is necessary for the combustion of 1 kg of wood, then the rate of burning R is equal to V'/L or with equation 1.1

$$R = \frac{aH'Bv_m'}{L} \qquad (1.2)$$

The average velocity v_m' can be derived by calcu[l]ating the local velocities and taking the average of these over the height H'. The local velocity can be found with the aid of Bernoulli's theorem. By assuming that the density of the gases is everywhere ρ_1 in the enclosure and the densities of the air outside ρ_0, the velocity v' of the inflowing air can approximately be given by

$$\tfrac{1}{2}\rho_0(v')^2 = gh'(\rho_0 - \rho_1) \qquad (1.3)$$

or

$$v' = \sqrt{\left(2gh'\frac{\rho_0 - \rho_1}{\rho_0}\right)} \qquad (1.4)$$

where ρ_0 = density of the outside air
ρ_1 = density of the gases in the enclosure
g = acceleration due to gravity.

The [av]erage velocity over the height H' is

$$v_m' = \frac{1}{H'}\int_0^{H'} v'\, dh' \qquad (1.5)$$

[In]tegration of equation 1.4 gives

$$v_m' = \frac{2}{3}\sqrt{\left(2gH'\frac{\rho_0 - \rho_1}{\rho_0}\right)} \qquad (1.6)$$

From equations 1.2 and 1.6 it follows that the burning rate R is proportional to $H'B\sqrt{(H')}$. When it is assumed that H' is proportional to the height of the opening H, the burning rate is also proportional to $HB\sqrt{(H)}$.

Thus

$$R = CA\sqrt{(H)} \qquad (1.7)$$

where C is a constant and $A = HB$ is the area of the opening in the enclosure. Experimental and theoretical values of C have been found in the range of 5·0 to 6·2 [1.3, 1.11, 1.12, 1.13]. The relation between the rate of burning R and the so-called ventilation factor $A\sqrt{(H)}$, which was derived from the experiments described in Reference 1.8 is shown in Fig. 1.3. The rate of burning, together with other factors such as wall material properties, and size of the enclosure, determines the temperature course of the burning and decay period and the

duration of these periods. Exposure hazard exists not only in the burning period but also in the decay period, as long as the temperature remains above approximately 300°C [1.3, 1.14]. This temperature is arbitrarily chosen. It can be shown, however, that at this temperature the rate of heat transfer from the fire to the exposed structure is

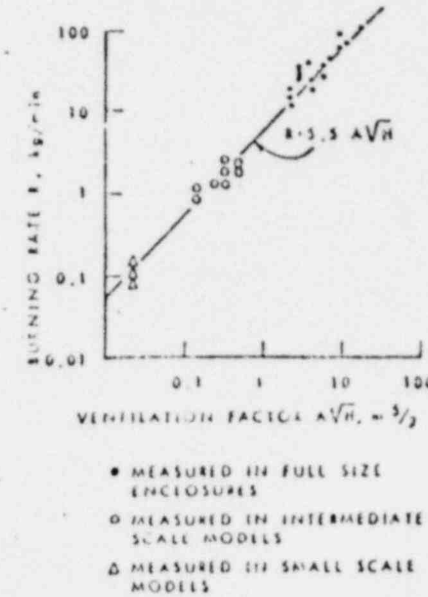

Fig. 1.3. Burning rate in an enclosure as a function of the window area and window height H for ventilation controlled fires according to Kawagoe and Sekine.

only a small fraction of the rate during the fully developed stage of the fire. When, [fo]r simplicity, it is assumed that the fire temperature in the fully developed stage is 1 000°C, and that the heat is transferred by radiation, which varies in proportion to the fourth power of the absolute temperature, then it follows that at 300°C the rate of heat transfer is about 4% of that during the fully developed stage. Although it is likely that 300°C is in general sufficiently low, there are exceptions, for example those cases where creep plays a role or where the temperature rise in the structure is retarded substantially, because of a high thermal capacity of the structure.

a NEW STANDARD which does not address this issue. True, if we do, there will be the argument on what we do about all the old devices which were tested to the standard when it did not require a pressure differential.

Perhaps the most striking comment was made to us by L. F. Hamilton, Engineer in Charge of Transmission and Distribution Engineering Section of the Philadelphia Electric Co. and closely associated with the IEEE task group which developed their 634 Standard when he said,

> "What concerns insurors and regulatory agencies is not the designed pressure differential on either side of the fire rated barrier, but the differential pressure which is generated by the design basis fire. This provision, therefore, does not meet the concerns, and I am only one of a legion who are at present stymied by the recent concern."

This letter is addressed to the "legion who are at present stymied by this concern."

There is no doubt that if we accepted a positive pressure we would see a legion of new negative votes. Indeed, John Ed Ryan said just that at our task group meeting. This is the difficulty in achieving an acceptable standard in ASTM. We represent both the scientific expertise of fire and the commercial interests of wood, gypsum, concrete, steel and plastics. Some of these interests always stand to loose in a new tougher standard.

It should be pointed out that the task group meeting at Northbrook felt that as long as we maintained the hose stream requirement we did not need to specify the positive pressure in the upper part of the test furnace. To some extent that is true, but I strongly doubt the legitimacy of the hose stream test. I would be willing to substantially relax the hose stream test as a trade-off for the positive pressure in the fire test, but the group at Northbrook on February 6, 1980 was neither large enough nor of the right mix for such a process.

Finally, on the basis of the foregoing discussion and the data given in the referenced material, I offer the following recommendations:

> *It is my recommendation that a positive pressure of 12.5 Pa (0.05 inches of water) be established as the standard pressure to be used in the subject fire test at the top of the furnace. Furthermore, I recommend that the neutral plane be kept between 1/3 and 1/2 of the height of a vertical test specimen.*

If any readers of this letter have any comments or questions please feel free to call me (415) 642-5308.

Sincerely,

Robert Brady Williamson

Robert Brady Williamson
Professor of Engineering Science

RBW/cj

bnl

BROOKHAVEN NATIONAL LABORATORY

ASSOCIATED UNIVERSITIES, INC.

Upton, New York 11973

Department of Nuclear Energy

(516) 345-2144

May 5, 1980

Mr. Robert L. Ferguson
Chemical Engineering
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Bob:

Your letter of December 12, 1979 concerning penetration seal qualification tests requested that Brookhaven National Laboratory (BNL) prepare a matrix containing the relevant seal qualification information for each plant. Appendix 1 attached tabulates each plant and indicates for each whether (1) staff position "A" was applied, (2) what was required for cable penetration qualification, (3) was hose stream test required, and (4) was differential pressure required. Additionally, your letter requested a statement of the criteria which established the Δp that should be used during each test. The balance of this report addresses this concern.

There is so much ambiguity concerning fire stop penetration testing that at the outset it might be well to set down a definition of positive Δp testing. In the context of this letter then, positive Δp testing will be defined as the exposure of one side of a penetration wall to a fire environment with pressure on the hot or fire exposed side at some pressure greater than that of the unexposed or cold side maintained for the duration of the test.

Historically fire penetration tests have been performed with the pressure on the exposed fire side at a lesser pressure than that of the unexposed cold side, it provided air inflow at leak areas preventing smoke and fumes from escaping into the test facility. Any leakage, therefore, provided an inflow of cold air which was not representative of the actual fire situation, and which in fact negated the test parameters in some cases.

Furnace design to provide positive Δp testing has not been standardized and, in fact, the only fire testing performed with a ... that we are aware of has been done