GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

no action adh OTL

Date: _October 4, 1977_

Project Title: _Continuation of Management and Technical Assistance by Georgia Institute of Technology, Industrial Extension Expansion Service Program_

Project No.: _A-2018_   _12/31/83_ _5/31/83_ _3/31/83_ _1/31/82_ _12/30/82_ _12/31/82_ _4/31/82_ _July 31, 1981_ → PERFORM

Project Director: _Hardy Taylor_

Sponsor: _U.S. Dept. of Commerce/EDA_

Agreement Period: From _7/1/77_   Until _9/30/78*_ _2/28/82_   _3/31/81 reports_

*12 mo. work period -
3 mos. for reporting, etc.

Type Agreement: _Grant No. 04-06-01567_   _4/28/82 - performance_ _3/31/84_

Amount: $75,000 EDA
    25,000 GIT Cost-Sharing
    $100,000

Reports Required: _Work Schedule Plan; Progress & Financial Reports; Final Technical and Financial Reports_

Sponsor Contact Person (s):

Technical Matters   Contractual Matters
                                          (thru OCA)
    Director
    S. E. Regional Office
    U. S. Dept. of Commerce/EDA
    1365 Peachtree St., N.E., Suite 700
    Atlanta, Georgia   30309

Defense Priority Rating:

Assigned to: _Technology & Development Laboratory_   (School/Laboratory)

COPIES TO:

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Dean/Director—EES   EES Information Office
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Procurement Office   Project Code (GTRI)
Security Coordinator (OCA)✓   Other _EES R&P_
Reports Coordinator (OCA)

CA—3 (3/76)

GEORGIA INSTITUTE OF TECHNOLOGY

OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date ___11/6/84___

Project No. ___A-2018___   ~~School~~/Lab ___EDL___

Includes Subproject No.(s) _____

Project Director(s) ___Hardy Taylor___   GTRI / ~~GIT~~

Sponsor ___U. S. Department of Commerce (EDA)___

Title ___A Program of Management and Technical Assistance in Designated EDA Counties in Ga.___

_____

Effective Completion Date: ___3/31/84___   (Performance) ___6/30/84___ (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [X] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] ~~Govt. Property Inventory & Related Certificate~~
- [ ] Classified Material Certificate
- [ ] Other _____

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Other ___A. Jones; M. Heyser___

_____

Form OCA 60:1028

TRADE ADJUSTMENT ASSISTANCE
PROVIDED TO
ATLANTA UMBRELLA COMPANY

Performed by
James Muller
Research Engineer

December 1978

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Acknowledgements

Preface

A technical assistance project requires a tremendous amount of personal
interaction with the client firm. The project in question was no exception.
The plant layout and office design phases were accomplished with a great
deal of consultation and revision. The consultant was on site and actively
assisting during every major undertaking, i.e., moving into the new facility,
installing new services, installing new equipment, negotiating with equip-
ment suppliers, interviewing key personnel, discussions with subcontractors,
etc. Twenty-eight site visits were logged during the course of the project;
three visits were made to the mold tooling contractor; two visits to building
contractors; and two out-of-state trips, one to a candidate mold maker and
one to an equipment supplier. An estimated 40 telephone conversations were
carried on with individuals of the client firm, and 20 telephone conversations
were held with third parties in behalf of the client firm.

Also, a great deal of behind-the-scenes research was carried on in the
course of the project. Secondary sources were consulted on processes,
materials, and equipment. In several instances, individuals with specialized
expertise were consulted when the needs arose. Always there was a consi-
derable amount of reflection before any document was prepared or any recom-
mendation made.

Many accomplishments were made as is evident from the entire new look
of the manufacturing plant. A number of other eminent accomplishments are
forecasted in the narrative portion of this report.

Introduction

Atlanta Umbrella Company, a manufacturer of umbrellas, began operations in 1965. The company has always been located in Decatur, Georgia, although it has moved twice since then.

The company experienced rapid growth during the first three years of operations attaining a sales level of $430,538 in 1968. In this same year the dollar value of umbrellas imported into the country doubled. The company's business began to soften after that, and the botton fell out in 1972 by which time the dollar value of imported umbrellas had redoubled. At this point imported umbrellas accounted for over half of the United States market.

Faced with this situation, many umbrella manufacturers were forced to close their doors; other manufacturers began to import umbrellas to wholly or partially meet their demands and reduce their own manufacturing costs. Atlanta Umbrella resisted the trend and continued to manufacture all of its umbrellas. Today Atlanta Umbrella is the only umbrella company to manufacture all of its umbrellas. This is not total victory, however, because the company has virtually lost all of its mass market for umbrellas and is surviving on its speciality umbrella business. Sales revenues in constant dollars fell to half of the 1968 high during the years following 1972; output fell to one-third of the 1968 level of production.

The company applied to the Economic Development Administration for trade adjustment assistance under the Trade Adjustment Act of 1974. The company's eligibility for trade adjustment assistance was certified in February of this year.

The company proposed a recovery plan centered around a one-piece-canopy umbrella invention of the principal of the company. This concept preempts many of the sewing operations necessary on conventional multi-panel umbrellas, and makes it possible to manufacture umbrellas of unusual aesthetic appeal. The principal also proposed to employ plastic molding and extruding operations to fabricate umbrella components which were being purchased from offshore suppliers. Seeing these two concepts as a strong rebuttal to imports, the Economic Development Administration committed $950,000 in loans to the company to implement its plan.

As part of this assistance the Economic Development Administration also providied up to $10,000 of free technical assistance to the company to help in getting the project underway. The Engineering Experiment Station was the successful bidder for the contract to help the company. This report covers in brief the assistance provided to the company during the past six months.

NARRATIVE

The first task that I undertook was to make a plant layout. No less
than 10 meetings with the principal at his previous place of business or
at the new site were necessary in gathering enough background information to
make the plant layout. In route, at least four plant layout arrangements were
discarded in favor of the final layout.

I first established the process flow and recorded it in a process flow
chart (drawing AUPL-1). The process reflected in this flow chart is the
proposed process to be employed in the manufacture of the one-piece-cover um-
brella. The one-piece-cover concept will preempt many of the sewing operations
now in effect on conventional multi-paneled umbrellas. New plastics molding
and extruding operations will be employed to produce many components of um-
brellas which are currently purchased from outside sources. Large-scale printing
and laminating processes are proposed to be performed on the piece goods material
so as to produce umbrellas of unusual aesthetic appeal.

Next, I constructed a relationship chart (drawing AUPL-2). This chart
systematically forces the investigator to consider factors other than material
flow when making a layout study. You will note on further reading that there
were many other considerations, some of which were very important to the
principal. I gave due consideration to his wishes, providing they did not vio-
late good layout practice to any great degree. The factors considered important
and the degree of their importance are illustrated on the referenced drawing.

By inspecting and measuring the operations in the previous, 6,000-square-
foot plant, I got a general idea of the size relationship of the areas, one to
another. I then scaled up the operation to provide five times the existing
capacity of the previous plant. It was necessary to make knowledgeable estimates
on some of the areas because no specific equipment had been selected for use in
these areas. Over half of the plant was in this latter category, making the
plant layout a rather abstract exercise. At this juncture, I decided to limit
the plant layout to showing only designated areas, since much of the equipment
presently in use is scheduled to be phased out, and most of the new equipment
would be decided upon at a later date. As an aid to understanding what I was
doing and for the sake of documenting the analysis, I constructed an activities
area and features sheet (drawing AUPL-3). This drawing shows how the area and

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service needs of the designated areas were beginning to take shape. Fortunately, the 20,000-square-foot facility leased by the principal appeared to be sized to the requirements of the future plant.

Initial observations on the leased building were: The building was completely air conditioned, reducing the amount of facilities engineering to that of advising on measures to increase effectiveness and comfort which will be addressed later. There was virtually no distribution of electrical power in the plant other than that for lighting and a few 110 volt-outlets, so departments could be located freely without consideration of priximity to power sources. Only one small 10 x 10 foot office was in evidence, so the need to design additional office areas seemed immediate and important.

After preliminary studies described above and lengthy consultation with the principal, I concluded that the overall concept to be followed in the plant layout, briefly stated, was to maintain a good material flow and to locate heat-producing machinery at the rear of the plant. Secondary considerations were to locate finished goods away from the loading dock, since pilferage was reported to have been a problem in the past, and to provide a clear view of the main process area from the office area, since close supervision of workers is highly valued. A great amount of automated materials handling equipment (i.e., conveyors) is not to be employed, as ware-in-process moves only a short distance between work stations, and the relatively small lots are easily handled by hand. A combination process and product layout was to be employed.

Reference is made to the plant layout study (drawing AUPL-4) in the following. Both shipping and receiving will be accomplished in the area adjacent to the two loading dock doors. The plant does not have the luxury of having separate areas for these two operations, but the relatively low level of activity in these areas lessens any requirement that they be separated. A good flow of material can be arranged to accommodate this situation, as will be seen in further reading.

Incoming raw materials will be moved by lift trucks down the wide aisle next to the south wall to the storage area provided at the rear of the plant. The haviest and bulkiest of the raw materials will be piece goods on rolls and plastic resin pellets in 1,000-pound Gaylord containers. Next in order of girth and weight will be the umbrella frames, and from there a large dropoff to the many much smaller umbrella components. The operations drawing piece goods and plastics resin are located directly adjacent to the storage area. This is

doubly important in the case of materials going to printing and laminating, since the materials will most often return to storage in the same area after processing. Materials going to molding, extruding, and layout/cutting will not return to the storage area but will proceed through their respective processes, eventually to reside in the finished goods inventory area.

Note that the raw materials storage area itself acts as a barrier between the heat-radiating machinery on the east and north ends of the plant and the labor intensive areas on the south and west ends of the plant. The principal contemplates separating these heat-producing machines from the rest of the plant by a curtain barrier of some sort at a later date; this layout will readily facilitate his idea.

Piece goods will follow an almost straight-line path through processing after being introduced into the flow via layout/cutting. Tips are applied in the tipping operation; tops, in the topping operation. Tie wraps are made from scraps of fabric generated in the die-cutting operation and are applied to umbrella canopies in the same area. Specialty sewing operations are performed as required; it is expected that sewing will become less and less necessary as the process matures, allowing more space for other operations. The canopy is fitted to the frame in the framing area. The opened umbrella base is steamed to remove wrinkles. Then the opened umbrellas are placed in tight formation on the plant floor and allowed to dry. When dry, the canopy is collapsed and rolled neatly, the tie wrap is snapped in place, and the topping ferrule is staked in place. Then the base is either put to stock or is sent to finishing. In finishing, the base in assembled with the proper handle and tip cup. Before packaging the umbrella is inspected and the logo tag is applied. The orders are collected and packed in shipping containers, and finally the containers are palletized in the shipping area for pickup by the carrier.

Plastics materials are moved to process from their storage place on the north side of the raw material storage area to an area generally between the two plastics operations. Pneumatic loaders move the pelletized material into charging hoppers on either molding or extruding machines. The plastics parts produced are put to stock in the east end of the finished goods storage area. It is conceivable that roller conveyors will be used to move boxes of parts from the processing area to the storage area. The plastics parts are then distributed from stock to using operations within the plant.

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The cafeteria, once the room in the extreme northwest corner of the building, was relocated to the plant floor to provide needed office space. It is felt that the designated cafeteria area will actually be more pleasing to the employees since it is more spacious in all directions and has better access to rest rooms and locker rooms.

The general traffic flow of personnel will be predominantly in the six-foot-wide aisles outside the rest rooms, beside the offices and cafeteria, and adjacent to the main processing area. Lift truck traffic will be restricted to the nine-foot-wide aisles.

It was decided that the layout as drawn and described above would be implemented, as nearly as possible, upon moving into the new building, realizing that gaps would exist which would later be filled in by new or additional equipment. It became immediately necessary to provide electrical services and lighting in the processing area since the move was imminent. I worked with an electrical contractor, previously used by the client, in designing the initial service plan (drawing AUPL-5).

During the move I was on site directing the placement of equipment. A move of this type is usually difficult, frustrating, and tiring. This one was especially so -- the move was accomplished during a very heavy rain storm, one piece of equipment would not fit through the loading dock door, and the roof of the new building leaked in a dozen or more places.

To expand on the leaking roof problem, the principal and I noted evidence of the roof leaks when we first inspected the building in June. The lessor was apprised of the condition at that time, and he agreed to resurface the roof before Atlanta Umbrella moved in. The lessor allowed the entire two dry months of July and August to slip by without starting on the roof, despite the constant requests by the principal. He finally got a roofing contractor on the job one day prior to the move, and immediately heavy rain set in and continued sporatically for about a week.

Back to the office design effort, at first it appeared that there was an immediate need to provide additional office space. The following were projected to be on the administrative staff: president, plant manager, controller, sales manager, two secretaries, and a bookkeeping clerk. There was only one 10 x 10 foot office in the building. I dissuaded the client from locating offices in the southwest corner of the building, pointing out that both the water and

electrical service entrances were located in this corner and that this area should be the employees' entrance. I suggested that the existing partitioned area be double decked in two phases: first, the empty mechanical services room should be converted to an office and reception area on the first floor with a mezzanine office above; at a later date, the locker room-restroom-cafeteria area should be double decked with a suite of offices. (See sketches of the final arrangement, drawings AUOL-1 and AUOL-2). I reviewed the plans with a building contractor and received a ball park price of $60,000 on the project. This expenditure could not be justified at this point in time. Therefore, I suggested that the cafeteria be relocated on the plant floor, freeing up this area for offices, and that the mechanical services room be converted to an office and waiting room. (Refer to finished drawing AUOL-3). The total cost to the contractor was estimated to be around $6,200, including heating and air conditioning installation. The principal added some embellishments after the drawing was made, which should bring the total cost to about $7,600. I sent the plans to three contractors selected by the client. Two visited the site, and one of these bid the job at around $11,000. The client has not yet made a "go" decision on the construction.

As previously mentioned, the leased building is totally heated and air conditioned. Following is a brief description of the systems and some suggestions for increasing their effectiveness.

Five gas-fired heating units are hung under the roof trusses. (Refer to drawing AUPL-4 for unit location and direction of delivery.) Four of the units are 225,000 BTU units and the one in the shipping and receiving area is a 105,000 BTU unit. I suggested that the unit on the east end of the plant be relocated to a position approximately 45 feet from the west wall and 12 feet from the south wall and directed northeasterly. This unit will not be needed on the east end of the plant, since all of the heat-radiating equipment is located there, and the main process area needs a source of heat nearby. The direction of the unit in the shipping and receiving area also could be reversed.

Additionally, I suggested that six or more free-hanging ducts designed to combat heat stratification be dispersed throughout the process area. Refer to Exhibit 1 for an explanation of this type of device, the names of several different suppliers of this type of device, energy saving estimates, and price lists.

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Setting the thermostats to a maximum of 68° during the period the plant is operating and setting them back to 55° when not operating should be standard procedure.

Four roof-mounted air conditioning units cool the manufacturing area. They are roughly located in the vicinity of the four "I" beam columns shown on drawing AUPL-4. They are, from west to east, one 10-ton unit, one 20-ton unit, one 10-ton unit, and one 10-ton unit. I recommend that only the 20-ton unit be run as a general rule. The western 10-ton unit could also be turned on when needed on unusually hot days. The other two units should be periodically turned on for short periods of time for exercise; air conditioning units deteriorate when they remain idle for long periods of time.

There is no ductwork associated with these air conditioning units; directional vanes direct cool supply air radially, and a central return air inlet draws warm air into the unit. Such units are not uncommon in industrial plants; they offer first cost advantages but are not very efficient. Some efficiency increase can be gained by extending the return air duct within eight to ten feet of the plant floor (in some instances a booster blower is required in long ducts). The rationale is that the air conditioning unit is prevented from returning the very hot air under the roof to the cooling coils. This is actually the reverse of the measure recommended to increase heating efficiency by preventing stratification; it actually promotes stratification. I do not recommend the above measure with a high priority because the efficiency gains are modest; then, only the 20-ton unit should be considered for retrofitting.

Setting the thermostat to a minimum of 72° during the period the plant is operating and shutting the units off when not operating should be standard procedure.

The electrical service needs of Atlanta Umbrella, present and future, are addressed in Exhibit 2. I supplied this brief to the company for its own use and for its negotiations with the Georgia Power Company.

Previously, I indicated that I worked with the company's electrical contractor in designing internal distribution of power (see drawing AUPL-5). Subsequent to this we installed a 460V, 3 ph, 200 amp distribution panel in the southeast corner of the plant, and we plan to install another panel of the same capacity on the north wall at the intersection of the molding and extruding areas. This will complete the major distribution of power within the plant.

When the initial business of laying out the plant, laying out the offices, and advising on facilities was completed, I began the equipment phase of the project. The principal had ordered several major pieces of equipment prior to the start of this project on which he required installation and start-up assistance. The principal required assistance in selecting some additional pieces of equipment. Finally, the principal wanted several pieces of specialized equipment designed and fabricated.

It was apparent that there were four or more separate good-sized projects involved under the general category of plant equipment. In an effort to avoid inefficient vacilation between projects, to outline the steps in accomplishing the projects, to give some structure for scheduling, and to give the principal a feel for the amount of time and effort involved in these projects, I did a brief PERT analysis of the projects (Exhibit 3). I reviewed the findings of this analysis with the principal. Clearly, the expectations of the principal were far in excess of what could be accomplished in the time span of a few months. My suggestions were to delay the delivery of the injection molding machine because the tooling would not be ready in time and to cancel the loan of a large die cutting machine because there was nothing to cut during the interim before the delivery of Atlanta Umbrella's own machine. The principal agreed to these suggestions and acted accordingly. Also, I suggested that Atlanta Umbrella actively recruit a production superintendent with a background in plastics because the firm was in need of both supervisory and technical personnel. I will cover this effort later in the narrative.

My work in assisting in planning the injection molding operation is summarized in Exhibit 4. In conducting this work I made direct contact with individuals employed by Cincinnati-Milicon, several suppliers of peripheral equipment for injection molding, and several mold makers. The molding machine arrived the last week in November. The peripheral equipment will arrive during the first week in December. I expect the first molding attempts will be made before the end of the year. The first production runs will be underway by February.

I participated in the selection of the layout table and clicker (die cutting press). Discussions between the manufacturer of the equipment, the local sales representative, the principal, and myself resulted in saving the principal $45,000 in the cost of this equipment. Going to progressive cutting made possible a significant reduction in the platen size and tonnage of the clicker, and the length of the layout table was reduced by eight feet. I

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devised a method whereby fabrics with patterns can be laid up in registration. This will require some design changes in the layout machine and will be undertaken when and if necessary. I accompanied the principal on a trip to the clicker manufacturer during which we made a final check out of the machine. The clicker was delivered in the last week in November. Installation is complete and the machine is ready for duty.

The principal purchased a transfer printing machine from a used machinery agent. The principal hoped to modify this machine to extend its use to laminating a plastic film on a fabric. He was advised by the equipment manufacturer that this concept had a high likelihood of success. I was skeptical and pointed out some potential problems but agreed that there were substantial benefits to be gained from getting double duty from the machine. The principal contracted the services of a service engineer from the original manufacturer of the machine to check out the machine and to assist in refitting it for its second duty. When the machine arrived, it was immediately apparent that the machine had seen much more service than the agent had represented. The service engineer arrived a few days later to perform his task; I assisted. We discovered that the machine was seven years old, was third hand, had been altered in several ways, and was generally in poor condition. The principal confronted the agent with these facts, upon which he reportedly agreed to cancel the sale, withdraw the machine, and return the down-payment. To my knowledge, final disposition of this matter has not been made.

The above events caused a setback in the firm's plans to get into the production of a one-piece umbrella canopy early next year. I advised the principal to consider contracting outside services for printing and laminating the fabric, thereby making it possible to meet the production schedule and giving time to carefully select printing and/or laminating equipment. The principal is now actively negotiating with several firms in this regard.

I accompanied the principal on an equipment shopping trip to the Bobbin Show/AAMA Convention which was held in Atlanta during September. We made contacts with several firms supplying equipment with possible applications suitable for Atlanta Umbrella. This equipment is under investigation. I made a suggestion that a belt-loop-making machine be employed to make umbrella tie wraps, which the principal readily accepted. He plans to order one or more of the machines very shortly.

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The principal also has become aware of the very popular use of pneumatic devices on automated equipment from seeing the devices on equipment at the Bobbin Show and noting that most of his new equipment will require air service. I am assisting the principal in determining his compressor needs, locating the proper compressor, providing services for the compressor, and routing the air plumbing.

The principal desires to use a snap-on plastic tip, automatically applied, instead of metal tips, sewed in place. I designed a tip (drawing AUMD-1) and started working on a conceptual design of a machine that would perform the tipping operation. Very little progress was made in that design due to the many other project tasks needing attention. Realistically, designing, fabricating, and debugging a piece of equipment requires a significant amount of time and effort. I estimate that it would require as much time as was allocated to the entire project to accomplish this one task.

The need for an automatic topping machine was satisfied by selecting and purchasing a machine; therefore, there will be no need to design such a machine as was originally stated.

The principal desires to automate the current canopy steaming operation (described in the preceding discussion on the plant layout) by employing some sort of conveyor to move the umbrellas through a steaming and then a drying process. Several configurations were considered before it was discovered that the steaming process would not be required on the one-piece canopy product. In the processing of the synthetic canopy material, temperatures of $300^{O}F$ and pressures of 400 psi will be employed; therefore, the material will not be susceptible to wrinkling in the normal processes of making umbrellas nor will it respond to anything as mild as a blast of saturated steam to remove wrinkles. The present steaming system will continue to be employed on the conventional product line, since the volume of this business is scheduled to remain constant or perhaps decrease after the introduction of the one-piece canopy product line.

The need for additional supervisory staff personnel at Atlanta Umbrella is most acute and is becoming more so as the scope of operation increases. The day-to-day problems and tasks associated with the new processes and attending new equipment are expanding at an exponential rate, and the marketing, supervisory, and business management needs are also beginning to increase. The principal and I discussed this matter when we reviewed the many tasks identified in the

PERT analyses. Realizing that only one additional individual could be justified at this time, we proceeded to describe an individual that would be best suited for satisfying both the immediate and long-range needs of the firm.

The firm needed a technical individual; this suggested that the individual be an engineer. The firm needed a manufacturing manager; this suggested that the individual have supervisory experience, if not as a plant manager, as something closely related. On the other hand, the firm needed someone who would actually get out on the plant floor and work with his hands, setting up equipment and trouble-shooting equipment. The latter requirement and the fact that the new individual would of necessity have to work in rather austere surroundings for some time and that his salary must start at a modest level until the firm has recovered made the task even more difficult. We termed this individual a "shirt-sleeved-manager" and proceeded in our search. I wrote two ads (Exhibit 5) and had them run in the "Georgia Tech Alumni Placement Bulletin". Several individuals responded. I reviewed their resumes and made recommendations. One candidate appeared promising. The principal had a personal interview with the individual. The principal desired to solicit more candidates. Therefore, the firm ran a classified ad in the Atlanta Constitution requesting applicants for the plant manager job. Twenty-two responses were received. Again I reviewed the resumes and made recommendations as to which candidates were most promising. The principal retained a testing service to administer a test to assenting candidates in an effort to quantify their merits and abilities. Three candidates were interviewed by both the principal and myself. Each candidate assented to and took the test. One of these individuals was hired. He does not have a degree, but he has the required experience in plastic molding and has been a production supervisor; also, he is a handy person, having basic knowledge in mechanical and electrical fields.

During the course of the project the principal and I conferred on many miscellaneous subjects. We discussed marketing strategy for the new product. In this vein, I provided the principal with world market information on umbrellas (Exhibit 6). This information was volunteered by Dr. Alexandrides, Professor of Management, Georgia State University. We discussed wage and salary administration and employee benefits. The principal presently feels that the vast majority of his hourly employees would object to any deductions in their paychecks to provide for benefits and that the firm could not comfortably carry any additional burden at this time. My ideas regarding a vacation

policy were favorably received and may aid the principal in making decisions in this regard.

RESULTS

A. Plant layout is completed.

    1. Lighting plan is completed. All lights presently needed have been installed and provisions are made for additional lighting.

    2. An air conditioning system was already in place in the plant. Recommendations were made that will increase the effectiveness of the system and decrease the operating cost.

    3. Adequate heating capacity was already in place in the plant. Recommendations were made as to moving and/or redirecting some of the units. Also, recommendations were made that will increase the effectiveness of the system and decrease the operating cost.

    4. Recommendations on the placement of each piece of equipment was made. Although the placement of discrete pieces of equipment was not shown on the plant layout drawing for reasons given in the narrative portion of this report, there was never any doubt as to placement of any of the equipment nor has it been necessary to move any of the equipment since its installation.

    5. There was practically no electrical distribution in the plant. A distribution plan for the entire plant was made, and 80% of the installation is completed.

    6. A forecast of electrical requirements for the plant was made, and pertinent information regarding energy management was provided.

    7. Extensive use of conveyors in the plant does not appear to be warranted. Plans are to use some roller conveyors in the plastics fabrication areas, but an exact layout is premature.

    8. Storage and shipping areas were designated in the layout. Spacing and orientation of shelving were directed personally by the consultant. Housekeeping, never a strong point of the firm, appears to be improving. Aisles for movement of personnel and material have been designated. A lift truck has been purchased, and there are plans to go to pelletized storage in the future.

9. Excellent facilities have been provided for the employees, including cafeteria, locker rooms, and well equipped rest rooms.

B. Machinery to be designed.

1. An automatic topping machine has been selected and purchased.
2. The need for an automatic steamer is doubtful as is explained in the narrative. In any event, the principal is in agreement that the automatic steamer is a very low priority project.
3. A new snap-on plastic tip was designed and some preliminary research for a design project was started. See narrative and recommendations for further clarification of this aspect of the operation.

C. Architectural designs and drawings were prepared for several different office arrangements. The consultant conferred directly with building contractors on these matters.

D. The consultant conferred directly with equipment suppliers in behalf of the client firm. Recommendations were made on every piece of equipment purchased and all tooling purchased.

No concentrated effort was made to formalize salary and wage administrations systems, but many aspects of this were discussed with the principal, including matters pertaining to benefits and vacations.

The consultant assisted in recruitment of personnel by writing advertisements, screening resumes, and interviewing candidates.

E. Estimated capital savings to the firm due to assistance by the consultant (does not include any cost of services):

Scale down of clicking machine*	$45,000
Layout of electrical services	1,000
Use cafeteria as office space	5,000
Cancel loan of clicker	4,000
Delay delivery of injection molding machine	500
Savings on mold tooling	5,000
Supervision during move	300
Abort retrofit of transcolorizer	4,000
Total	$64,800

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F. Estimated annual savings due to assistance by the consultant over
    and above substantial savings inherent in the recovery plan:

New tie-wrap making machine	$ 8,000/yr
Heating savings	1,000
Air conditioning savings	1,000
Total	$10,000/yr

*As indicated in the narrative this saving was made possible through the
 collaboration of the equipment manufacturer, the sales representative,
 the principal and the consultant.

REMAINING WORK

1. Design an automatic tipping machine。

2. Start up injection molding operation.

3. Assist in deciding whether to and/or how to process price good materials in plant.

EXHIBITS

Exhibit 1

Hot ceilings & cold floors in your plant are signs of a common problem: heat stratification.

Now you can do something about it.

Heat rises. In most industrial and manufacturing buildings that means heated air builds up near the ceiling where it is wasted, while employees work near the cold floor. This phenomenon is called heat stratification, and occurs with nearly all heating systems.

So what? First, it wastes your heating dollar. Seventy-five percent of building heat escapes through the ceiling. The higher the ceiling temperature, the greater the rate of heat loss. Insulation slows the heat loss rate, but cannot prevent stratification.

Second, cold work areas mean employee discomfort. And that can mean diminished dexterity from cold hands, low morale, and high absenteeism during winter months. Now there's StratoTherm® to make your present heating system more efficient, at very little cost.

The principle is simple. StratoTherm® draws in heated ceiling air and gently discharges it at floor level. This action establishes natural convection circulation of room air.

Here's what it can mean to you.

Save up to 24% or more on heating costs. We're confident that *if* your building suffers from heat stratification, StratoTherm® units properly installed and used will easily pay for themselves in heat savings within one year.

Make your plant more comfortable. You'll feel the difference, and your employees will too. Typically, you can expect to raise floor temperatures from 5° to 10°, while actually lowering heating costs.

Utilize secondary heat sources. Every plant receives a substantial amount of heat from secondary sources such as solar energy, machinery and processes, electric lighting, and workers' caloric loss. StratoTherm® helps circulate that heat, so on sunny winter days your heating system can run less, and on occasion may not be needed at all.

Read the details at right and on the next page. Then consider the economies and increased productivity it can mean for your company.

Get that wasted heat back into circulation for better plant comfort and up to 24% savings in heating costs alone.
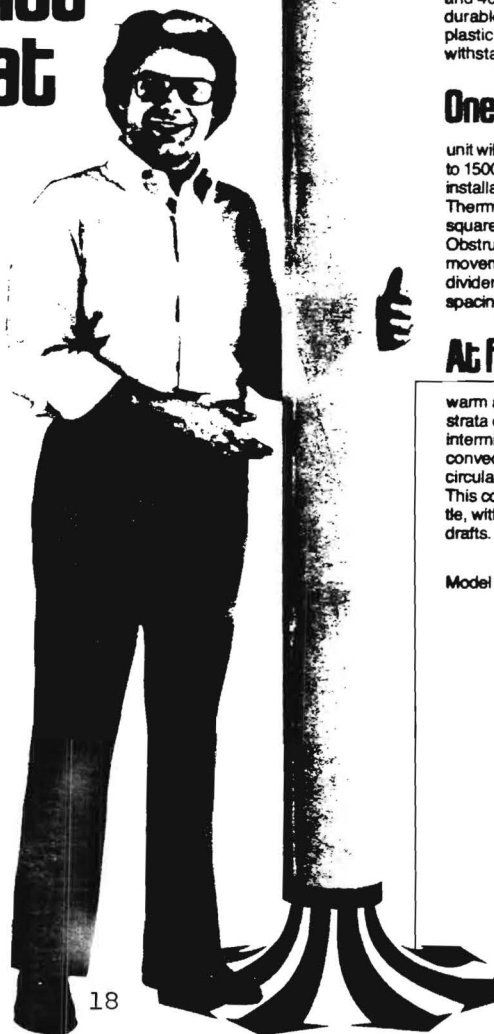
Ceilings

of industrial buildings are a hotbed of heat stratification. Warm air stagnates in a layer against the ceiling, resulting in large temperature differences between the floor and ceiling. To achieve even a brisk 60° at working levels may mean ceilings reach 95° to 100°, resulting in excessive thermal loss through the roof. The more ceiling temperatures are reduced by StratoTherm®, the greater the savings.

Power units

are engineered for maximum efficiency, using about 20 watts. They should be placed within 18″ of the ceiling. Warm air is continuously forced to floor level through the inflatable ducting at the rate of 120 cubic feet per minute. The fan motor is UL listed and guaranteed for three years operation. Installation is simpler than hanging a light fixture.

Ducting

may be easily adjusted to fit any ceiling height. Available in standard lengths of 20′, 30′ and 40′. Lightweight and durable heavy duty inflatable plastic ducting is flexible to withstand accidental contact.

One StratoTherm™

unit will de-stratify an area of up to 1500 square feet. In multiple installations, each Strato-Therm® will de-stratify 2000 square feet of floor area. Obstructions to the room's air movement, such as area dividers, may require closer spacing of units.

At floor level,

warm air is exhausted into the strata of dense cold air. It intermixes and rises, forming a convection current which circulates from floor to ceiling. This continuous mixing is gentle, with no noise or harsh drafts.

Model SP

STRATO THERM™ HEAT SYPHON™
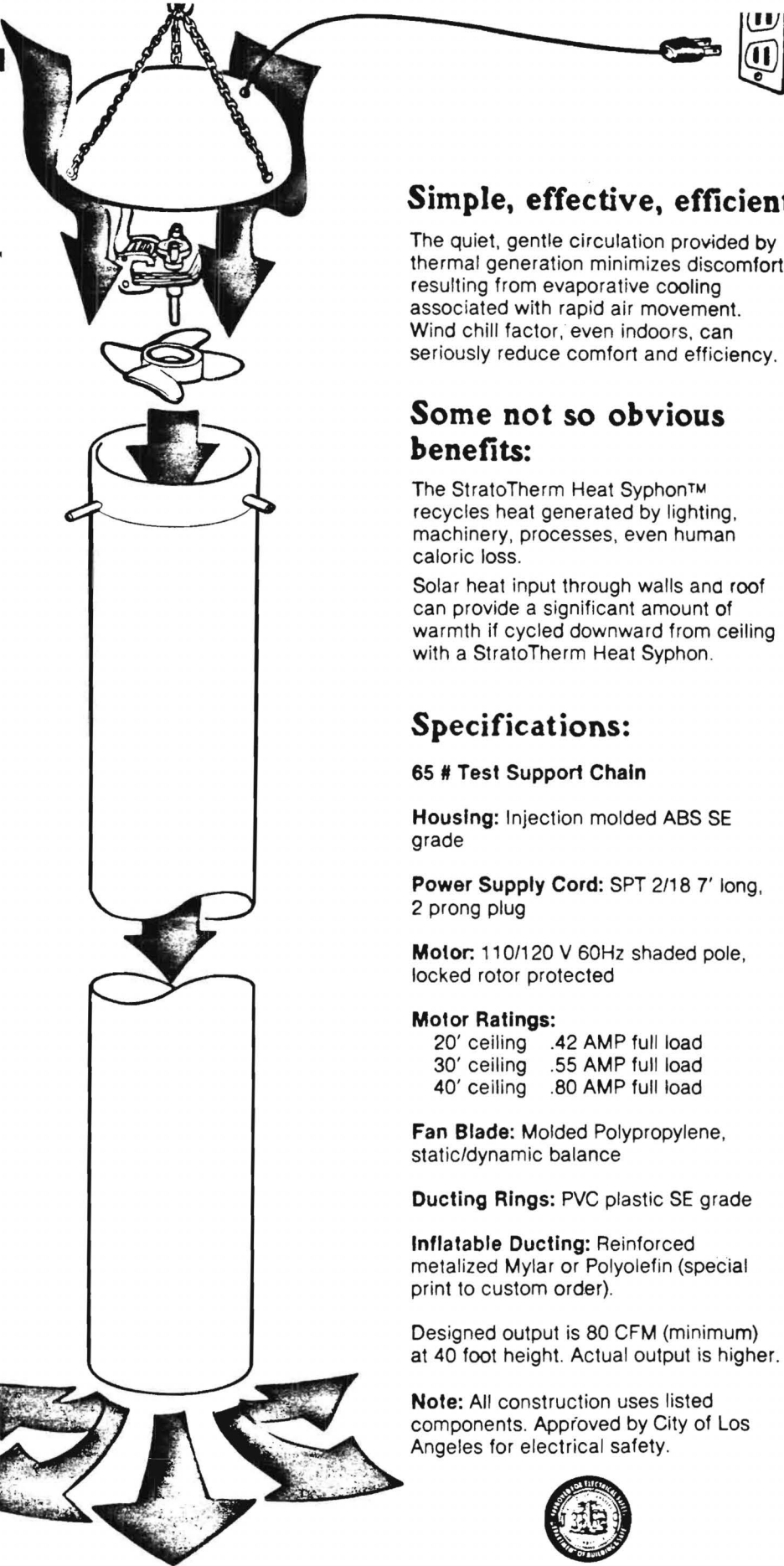
Solving the problem

Mother Nature provides the simplest solution, which is itself, the cause of the problem. Heat rises.

Using that simple physical phenomenon, the heat syphon recirculates stratified heat at super efficiency, functioning as a thermal (convection) generator. It takes a modest but continuous supply of air off the ceiling and delivers it to the floor. Mixing with the colder air at floor level, it creates a gentle rising current, a thermal. This continuous action results in a substantial increase of floor temperature. . .a decrease in ceiling temperature.

Warmer floors mean increased employee comfort, higher working efficiency, reduced absenteeism.

Lower ceiling temperatures

Means an immediate and direct reduction in your cost of heating. In a typical stratified situation, differential temperatures, ceiling to floor, range up to 30 degrees, often more. A reduction of just 15 degrees at ceiling level will convert to a floor increase of 5 to 10 degrees and a reduction in cost of heating in the range of 10% to 24% and more.

How much savings?

Impossible to say for sure—too many variables. A fair guess is at least 10% of direct costs, plus dramatic improvement in work environment.

Installation costs? For a 20 foot ceiling, about **2-1/2c per square foot** of floor area, and the actual installation is a simple hang-it-up and plug-it-in. Operating cost is about the same as a 40 watt light bulb.

Pay back? Obviously faster in Ohio than Florida. . .within a few months in some cases. Savings will continue.

Simple, effective, efficient

The quiet, gentle circulation provided by thermal generation minimizes discomfort resulting from evaporative cooling associated with rapid air movement. Wind chill factor, even indoors, can seriously reduce comfort and efficiency.

Some not so obvious benefits:

The StratoTherm Heat Syphon™ recycles heat generated by lighting, machinery, processes, even human caloric loss.

Solar heat input through walls and roof can provide a significant amount of warmth if cycled downward from ceiling with a StratoTherm Heat Syphon.

Specifications:

65 # Test Support Chain

Housing: Injection molded ABS SE grade

Power Supply Cord: SPT 2/18 7' long, 2 prong plug

Motor: 110/120 V 60Hz shaded pole, locked rotor protected

Motor Ratings:
20' ceiling	.42 AMP full load	
30' ceiling	.55 AMP full load	
40' ceiling	.80 AMP full load	

Fan Blade: Molded Polypropylene, static/dynamic balance

Ducting Rings: PVC plastic SE grade

Inflatable Ducting: Reinforced metalized Mylar or Polyolefin (special print to custom order).

Designed output is 80 CFM (minimum) at 40 foot height. Actual output is higher.

Note: All construction uses listed components. Approved by City of Los Angeles for electrical safety.

Heat Syphon units fit any ceiling, any size plant.

Operational Testing Profile:

Data generated during six day period, January 1977.

Building: concrete tilt-up construction, slab floor on grade. Ceiling height 20 feet. Floor area 5000 feet. Ceiling construction; metal corrugated, 2" insulation. Gas fired blower heat, mounted 15 feet above floor. Thermostat 60" above floor in central location. Two 10 x 12 foot shipping/receiving doors, one at each end of 50 x 100 foot structure. Located in Beaverton, Oregon.

Averages of three day test, January 21/23. Heat Syphons not running. Heat "on" at 0800, set at 65 degrees. Average outside temp., 39 deg. F. "Off" at 1630.

Averages of three day test, January 12/14, 1977. Heat "on" at 0800 set at 65 degrees. Average outside temp., 38.3 deg. F.

Tests made with two SP-20 units running continuously.
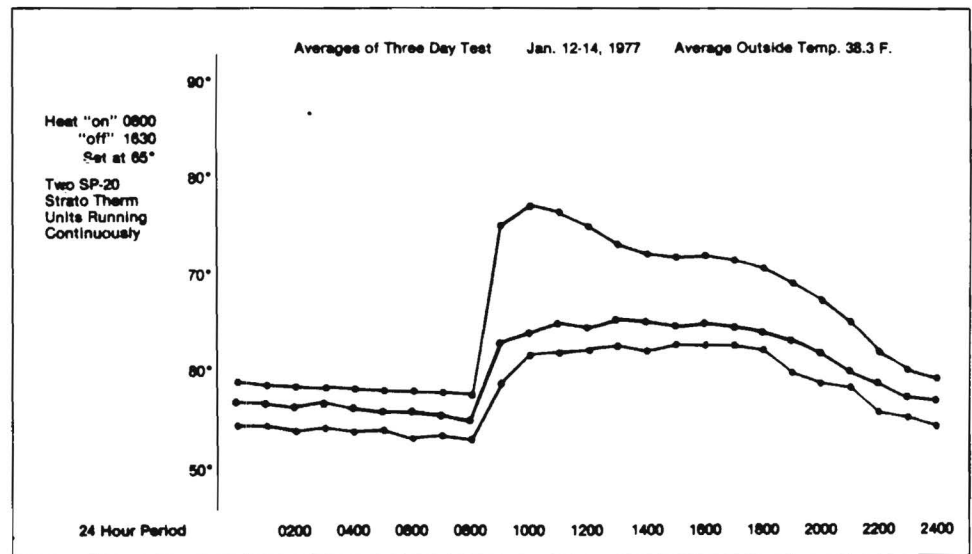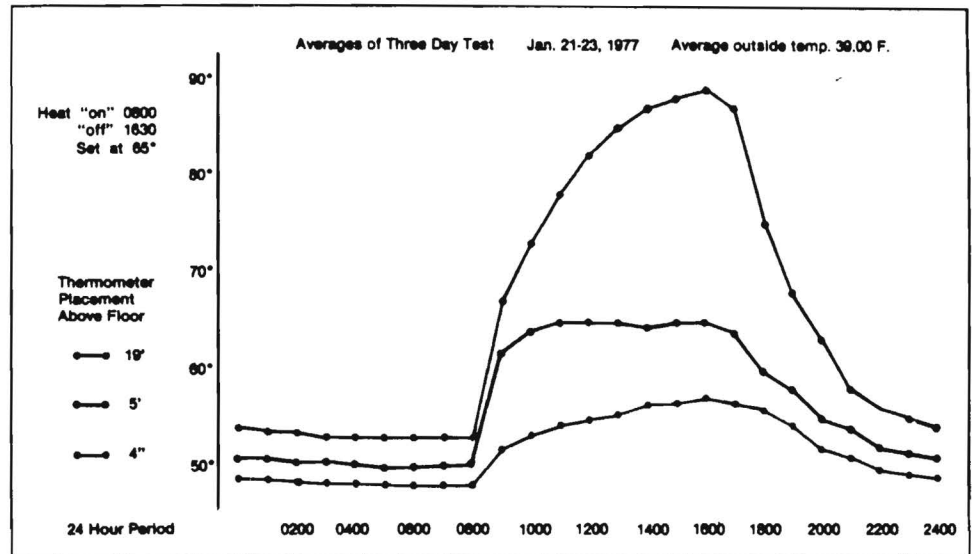
A Guarantee?

If you've got hot ceilings—cold floors

If you install heat syphons according to recommendation

If you will leave them operating continuously

If you follow normal conservation practices, then

We guarantee that heat syphons will reduce ceiling to floor temperature differentials, resulting in:
   Warmer working areas
   Reduced ceiling heat loss
   Reduced heating cost
   Increased employee benefits

Averages of Three Day Test   Jan. 21-23, 1977   Average outside temp. 39.00 F.

Heat "on" 0800 "off" 1630 Set at 65°

Thermometer Placement Above Floor
19'
5'
4"

Averages of Three Day Test   Jan. 12-14, 1977   Average Outside Temp. 38.3 F.

Heat "on" 0800 "off" 1630 Set at 65°

Two SP-20 Strato Therm Units Running Continuously

Rusth Industries, LTD.
P.O. Box 1519 Beaverton, Oregon 97005
(503) 644-2582

STRATO THERM HEAT SYPHON
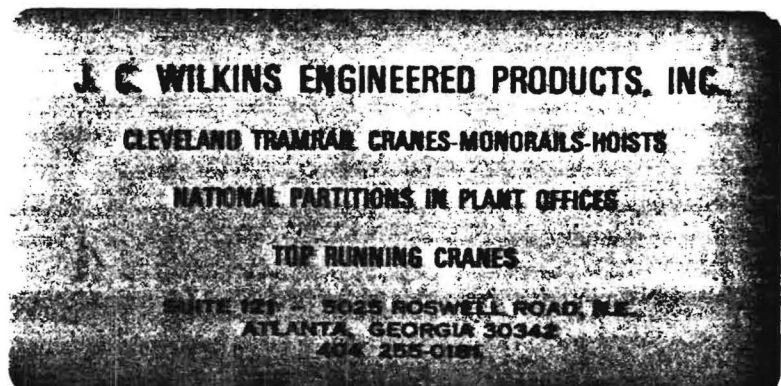
Enclosed is the StratoTherm information you requested. Heat savings in the area of 24% are common; in fact, we GUARANTEE a minimum savings of 10% or your money back!

WHAT IS STRATOTHERM? StratoTherm is an effective heat reclamation system which brings the warm air accumulated at the ceiling back down to the floor and into circulation.

HOW DOES IT WORK? By gently and continuously injecting the stratified warm air into the colder strata at the floor, a convection current is established and "Mother Nature" does the rest.

HOW MANY UNITS ARE REQUIRED? In multiple installations, each unit will de-stratify 2,000 square feet, so divide your total square feet by 2,000.

20, 30 OR 40 FOOT MODEL? The three models have been specially designed to handle varying ceiling heights. For ceiling heights of up to 20 feet, the 20 foot model; for 21' to 30' ceilings, the 30 foot model; for 31' to 40' ceilings, the 40 foot model. All three are easily and quickly adjusted to any shorter length.

PRICE? On a square foot basis, the price of the 20, 30 and 40 foot models is 2.5¢, 3.1¢ and 3.3¢, respectively with the unit price as shown on the enclosed price list.

OPERATING COST? The 20' model operates at about the same cost as a 20 watt lightbulb, other models are proportionately higher.

INSTALLATION? Simply hang the units equidistant apart throughout the facility, within 18 inches of the ceiling peak, the flexible ducting falling to within 18 inches of the floor, and plug in to a 110/120 volt outlet.
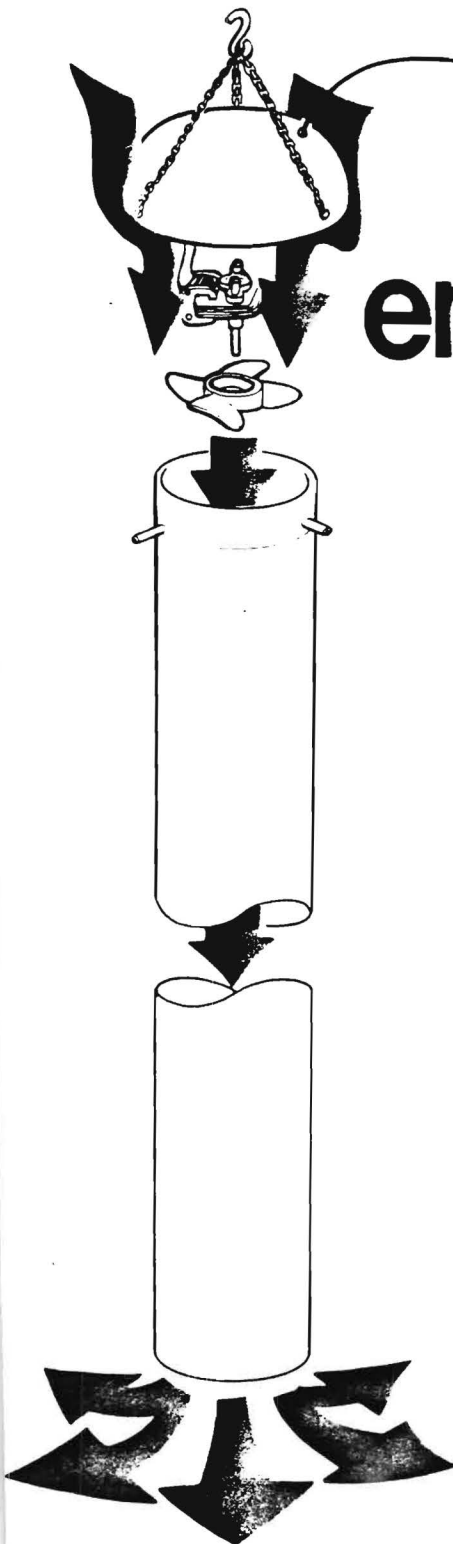
MOTOR RATINGS

CEILING	CFM	AMP	WATT	HP	KWH/MONTH
20'	120	.42	46	.062	36
30'	100	.55	60	.08	43
40'	80	.80	88	.12	63

BASED ON 3¢/KWH - OPERATING COST/1000 SQ. FT./MONTH IS 54¢, 65¢ & 95¢ RESPECTIVELY

Distributed By: J. C. WILKINS ENGINEERED PRODUCTS, INC.
         5025 Roswell Road, N.E. - Suite 121
               Atlanta, Georgia
               Phone: (404) 255-0181

RUSTH INDUSTRIES • P.O. BOX 1519 • BEAVERTON, OR 97005 • (503) 644-2582

IR-20

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Exhibit 2

Plant Electrical Service
Atlanta Umbrella Company

Atlanta Umbrella Company will soon venture into a new dimension in
electric power usage. The company had formerly experienced electric
power usage similar to that of a large residence. In fact, the company
was not even being billed for demand, only usage. With planned addition
to the plant equipment of an injection molding machine, a plastic extruder,
a plastics film laminating machine, and a sublimation printing machine the
whole situation is going to take on a difference complexion. A close look
at operating practices vrs. demand charges must be taken to ascertain if the
company should diverge from its present operating scedule of eight-hours-per-
day five days per week. This analysis should be redone periodically as
electric rates increase or operational changes are necessary.

The attached discussion on "Demand Control" is included for the companies'
use. The company is encouraged to keep track of demand charges so that it
doesn't pay more for its electric power than it should. There are a couple
of things to note: firstly, in some cases it may be more economical to pay
large demand charges rather than change efficient operations for the sake of
minimizing those charges; secondly, you can always lower your cost of ele-
ctricity if you simply don't use as much.

The new facility recently tenanted by Atlanta Umbrella has the potential
for a huge amount of electric power. The main breaker box is sized for 460
volts, 1200 amps. However, this amperage is not currently available, the
limitation being a 150 KVA transformer currently feeding power to the building.
In short, there is only about one quarter of the advertised capacity available
at this time.

There is absolutely no cause for alarm because the capacity available

will be adequate for the current operation of Atlanta Umbrella. With the above mentioned additions of equipment, electrical capacity will have to be expanded by installing a transformer with a higher rating. Georgia Power Company will do this for their customer if the customer will supply an estimate of what will be needed. Following is my rough estimate of the eventual peak demand of Atlanta Umbrella.

Air conditioning	90KW
Lighting	10
Misc. 110/220v	45
Die cutting machine	8
Extruding machine	36
Molding machine	36
Printing machine	60
Laminating machine	60
Bubble machine	40
Total	385 KW

Distribution of 460 volts in the building is very limited. Evidently the only equipment in the plant using 460 volts was the air conditioning units. I can foresee installing a 460 volt distribution box in the rear of the plant to service the new equipment.

A good network of 277 volt service exists for lighting and any additional lighting that might be installed.

220/110 volts are supplied via a 45KVA transformer in the building. A reasonably extensive network of 220/110 volt service exists throughout the building and could be extended without much trouble. The present transformer should prove adequate if all incoming major equipment is to operate on 460 votls.

DEMAND CONTROL

INTRODUCTION

The first item to cover when talking about demand control
is the term itself. What is "demand"? How does it affect your utility
bill? The method for calculating billing demand and ways of controlling
it are discussed in this section.

BILLING DEMAND

Most utilities charge their industrial customers on the
bases of their energy consumption (KWH) at a rate determined by their
demand (KW). The demand factor is built into the rate structure to
allow the utility to recoup their capacity expenses (e.g., sizes of
generating units, transmission lines, substations, etc.). It is much
less expensive for the utility to supply 100 KW for 400 hours per month
(40,000 KWH) than to supply 4,000 KW for 10 hours per month even though
the energy is the same.

A copy of Georgia Power Company's industrial rate schedule
"PL-1" appears at the end of this section. On this schedule is the
formula for determining the billing demand. Essentially, the demand for
a given month is the maximum amount of energy (KWH) used over any 30-minute
period. As a simple example, if two 100-watt light bulbs are operated
over a 30-minute period, the demand is 200 watts. During the next 30-
minute period, if one of the bulbs is turned off after fifteen minutes,

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the demand would be only 150 watts. However, because the billing demand

is based on the maximum amount of energy used over any 30-minute period,

the customer is charged for both periods at a rate determined by the

200 watt usage.

The billing demand is used by the utility company to deter-

mine the electricity rate. From the Georgia Power schedule, for the

summer months, June-September, it is the highest of (1) the current

month's actual demand, (2) ninty-five percent of the greatest actual

demand of any preceding summer month, or (3) sixty percent of the greatest

actual demand of any preceding winter month. For other months, October-May,

the billing demand is determined to be the great of (1) ninty-five percent

of the highest actual demand for any preceding summer month, or (2) sixty

percent of the highest winter month (including the present month). Thus

demand control is a year-round concern.

LOAD FACTOR

A useful formula in developing a program of demand control is that for the load factor.

$$\text{Load Factor} = \frac{\text{Total monthly KWH usage}}{(\text{Peak KW demand}) \ (24) \ (\text{No. of days in the month})}$$

A load factor of 100% would be attained if a plant were operated 24 hours per day, seven days per week at the peak demand level. Obviously, this is impractical. Even if a good load schedule is maintained through the day, the reduced load at night and on the weekends will keep the load factor well below 100%. However, for optimum electrical efficiencies, plant management should strive to maintain as high of a load factor as possible.

The way to improve the load factor is to level the peaks in the demand profile. This involves an assessment of the plant's loads to determine which ones can be rescheduled or turned off as the demand begins to rise. Air conditioners, hot water heaters, air compressors, electric boilers, battery chargers are examples of the types of equipment that can be turned off intermittently to avoid high levels of energy consumption. It may be beneficial to reschedule a particular process or operation to a second shift if the demand for the first shift is high. Nonroutine tasks such as testing new pieces of equipment should be judiciously scheduled for periods of low demand. It is to be pointed out that once a given demand has been exceeded during the month, there are no particular benefits as far as rate structure is concerned for operating at a lower power consumption rate.

Figure 5-1a illustrates the demand profile over a 24-hour period for the Wemakit Widget Co. prior to any type of demand control. The largest peak has occured just after 10:00 am. Assuming that no higher peaks occur during the month, the Wemakit Widget Company will be

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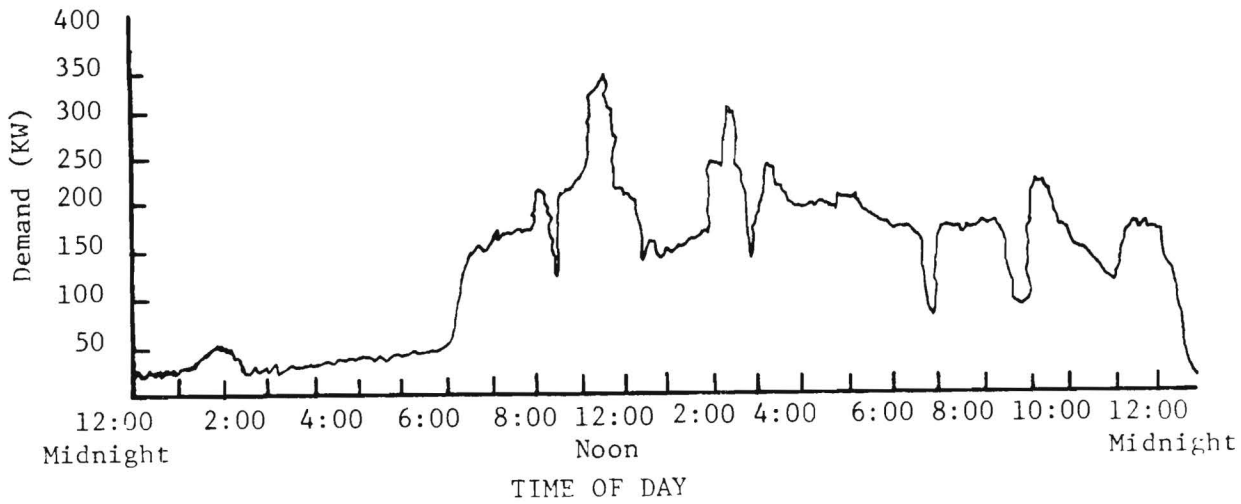
FIGURE 5-1a

FIGURE 5-1b
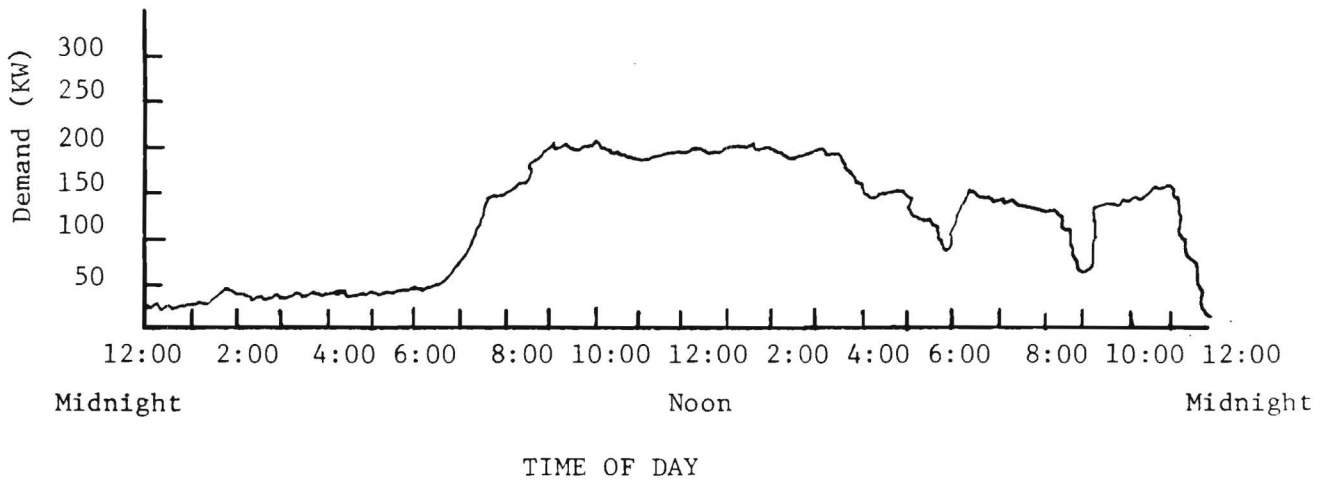
billed for all of their electricity based on a 325 KW demand. They
use an average of 135 KWH per day for a load factor of 42%.

In an effort to reduce their utility rates, the management decided
to adopt a demand control program. By rescheduling two of their processes
to the evening shift, and restricting the nonroutine operations to early
morning or evening hours, they developed the demand profile shown in
Figure 5-1b. Note the absence of pronounced peaks. Although the total
energy consumption of the company has not changed, the demand has been
reduced to 200 KW. The load factor is raised to 68%. The relatively
smooth curve reflects the increase in load factor due to optimum load
scheduling.

DEMAND CONTROL EQUIPMENT

Having reduced the demand to the extent possible by setting production schedules, the plant manager may wish to consider automatic demand control equipment. Some of the questions which he should seek to answer are:

1) What are the potential savings with reduced demand?

2) How much of these savings can be attained simply with the cooperation of plant personnel?

3) Will a simple on-off load limiting device with, perhaps an alarm serve the purpose, or

4) Would an automatic demand control system be justified?

Obviously, a plant operating with a relatively high load factor does not have as much potential for demand control equipment as one which experiences infrequent demand peaks. And if a substantial portion of the demand can be reduced without expensive equipment, the economic justification for its purchase may be invalid.

There are two general techniques for automatically controlling demand. The first of these is to turn off loads periodically during peak demand periods. Examples of the loads selected are air conditioners, hot water heaters, electric furnaces, etc. - any device that may have a"fly-wheel" effect. In addition to trimming the demand, this technique also has the advantage of actually reducing energy consumptions.

On-off load limiting devices monitor the instantaneous power consumption and compare it with a preset upper limit. When the consumption rate exceeds the limit an internal timing device turns the equipment off

for say, five minutes. Because the demand is based on the power supplied over a 30-minute period this technique is an effective way for reduction.

A more sophisticated method employs a Floating Demand Setpoint Technique. With the aid of a computer, incoming feeders are monitored. As the power consumption increases, the computer takes the necessary action to avoid exceeding the peak demand limit. By turning loads on or off on a priority basis the computer guides the consumption rate to the preset maximum. If the demand exceeds a previous setpoint, the new setpoint is established since there is no longer any incentive for operating at a lower power consumption level. Deferred loads are turned on with available power capacity to achieve higher load factors.

While the primary functions of automatic demand control equipment is to manage power consumption, it can also be used to establish records on the performance of the plant it monitors. These records will be helpful in scheduling equipment maintenance, comparing current and previous performance and locating potential areas of improvement in demand control.

GEORGIA POWER COMPANY

Power and Light

SCHEDULE "PL-1"

AVAILABILITY:

Throughout the Company's service area from existing lines of adequate capacity.

APPLICABILITY:

To all electric service required on Customer's premises, delivered at one point and metered at or compensated to that voltage.

All service subject to the Rules and Regulations for Electric Service on file with the Georgia Public Service Commission.

TYPE OF SERVICE:

Single or three phase, 60 hertz, at a standard voltage.

MONTHLY RATE — ENERGY CHARGE INCLUDING DEMAND CHARGE:

First	50 kWh or less	@	10.0¢ per kWh
Next	1,450 kWh	@	6.5¢ per kWh
Next	1,500 kWh	@	6.2¢ per kWh
Next	7,000 kWh	@	5.5¢ per kWh
Next	190,000 kWh	@	4.4¢ per kWh
Next	300,000 kWh	@	3.81¢ per kWh
Over	500,000 kWh	@	3.5¢ per kWh

All consumption (kWh) in excess of 200 hours and less than 400 hours times the billing demand....@ .... 1.5¢ per kWh

All consumption (kWh) in excess of 400 hours times the billing demand ....@.............. 1.3¢ per kWh

Minimum Monthly Bill:

A. $5.00 per meter plus $3.50 per kW of billing demand in excess of 5 kW. Plus excess kVAR charges and fuel adjustment as applied to the current month kWh.

B. Metered Outdoor Lighting: The lesser of (1) that determined from paragraph "A" above, or (2) $15.00 per meter for metered outdoor lighting installations, provided service is limited to the lighting equipment itself and such incidental load as may be required to operate coincidentally with the lighting equipment.

FUEL ADJUSTMENT:

The amount calculated at the above rate is subject to increase or decrease under the provisions of the Company's Fuel Adjustment Rider, Schedule "FA-2".

DETERMINATION OF BILLING DEMAND:

The Billing Demand shall be based on the highest 30-minute kW measurements during the current month and the preceding eleven (11) months. For the billing months of June through September, the Billing Demand shall be the greatest of (1) the current actual demand or (2) ninety-five percent (95%) of the highest actual demand occurring in any previous applicable summer month or (3) sixty percent (60%) of

the highest actual demand occurring in any previous applicable winter month (October through May). For the billing months of October through May, the Billing Demand shall be the greater of (1) ninety-five percent (95%) of the highest summer month (June through September) or (2) sixty percent (60%) of the highest winter month (including the current month). In no case shall the Billing Demand be less than the contract minimum nor less than 5 kW.

Where there is an indication of a power factor of less than 90% lagging the Company may at its option, install metering equipment to measure Reactive Demand. The Reactive Demand shall be the highest 30-minute kVAR measured during the month. The Excess Reactive Demand shall be kVAR which is in excess of one-half the measured actual kW in the current month. The Company will bill excess kVAR at the rate of $0.20 per excess kVAR.

TERM OF CONTRACT:

Not less than one year up to and including 500 kW maximum anticipated 30-minute kW, nor less than five years over 500 kW maximum anticipated 30 minute kW.

Effective for service rendered on and after September 18, 1977

GEORGIA POWER COMPANY

Off-Peak Service Rider

SCHEDULE "OP-1"

APPLICABILITY:

Applicable upon request as a modification of rate schedules PL-1, MP-1, and G-1 when off-peak usage exists.

DEFINITIONS:

A. Off-peak usage is defined as power requirements occurring between the hours of 10:00 p.m. and 7:00 a.m. daily or Saturdays, Sundays and Certain holidays. The day on which the holiday is observed shall count as an off-peak day. The holidays are New Year's Day, Memorial Day (May 30), Fourth of July, Labor Day, Thanksgiving Day, and Christmas Day.

B. On-peak usage is defined as all power requirements not included in (A) above.

DETERMINATION OF BILLING DEMAND:

Billing demand as modified by this rider shall be the greater of

(1) Sixty percent (60%) of the highest current or preceding eleven (11) months off-peak demand or

(2) The billing demand determination based on the on-peak demand as specified in the applicable rate.

METERING:

Option I — Where special metering must be installed specifically for the purpose of measuring off-peak usage and the customer specifically requests graphic metering, the charge of $25.00 a month will be added to the customer's bill to cover the graphic metering expense.

Option II — The Company's standard method of metering off-peak usage will be two demand meters in conjunction with a time clock. The charge for such metering will be $13.00 a month for the additional metering expense. This method will not recognize holidays as off-peak usage.

Customers normally operating off-peak, as defined above, whose monthly power requirements normally are less than 100 kWh per kW, may, at the Company's option, require no special metering.

GENERAL:

Service hereunder subject to Rules and Regulations for Electric Service on file with the Georgia Public Service Commission.

Effective for service rendered on and after September 15, 1977

BILLING DEMAND DETERMINATION

MONTH	YEAR	ACTUAL KW
January	_____	_____
February	_____	_____
March	_____	_____
April	_____	_____
May	_____	_____
June	_____	_____
July	_____	_____
August	_____	_____
September	_____	_____
October	_____	_____
November	_____	_____
December	_____	_____

Summer Months (June - Sept.)

Highest of	(1)	100% of current month
	(2)	75% of highest summer month
	(3)	60% of highest winter month

Winter Months (Oct. - May)

Highest of	(1)	95% highest summer month
	(2)	60% highest winter month

Exhibit 3

PERT ANALYSIS

Network   — Two mutually exclusive networks are drawn on the following page. The larger network represents the entire recovery project; the smaller one is for the office space project.

Events   — Significant events are pictured as modes on the network drawing. A description of the events follows the network drawing.

Activities   — Significant activities are pictured as vectors on the network drawing. A description of the activities follows the network drawing. Three estimates of activity time were made: optimistic, most likely, and pessimistic. Time estimates are in working days.

Results   — Expected completion time for each activity is labeled on the network drawing. The critical paths are shown in double line vectors. Note that two intermediate critical paths are shown, which represent completion of significant intermediate projects. Slack time is indicated on major non-critical branches.

Projects	Expected Completion in days	Network Standard Deviation
Office Construction	50.47	4.23
Injection Molding	97.84	5.91
Fabric Printing	67.52	4.42
One Piece Umbrella	174.50	12.16
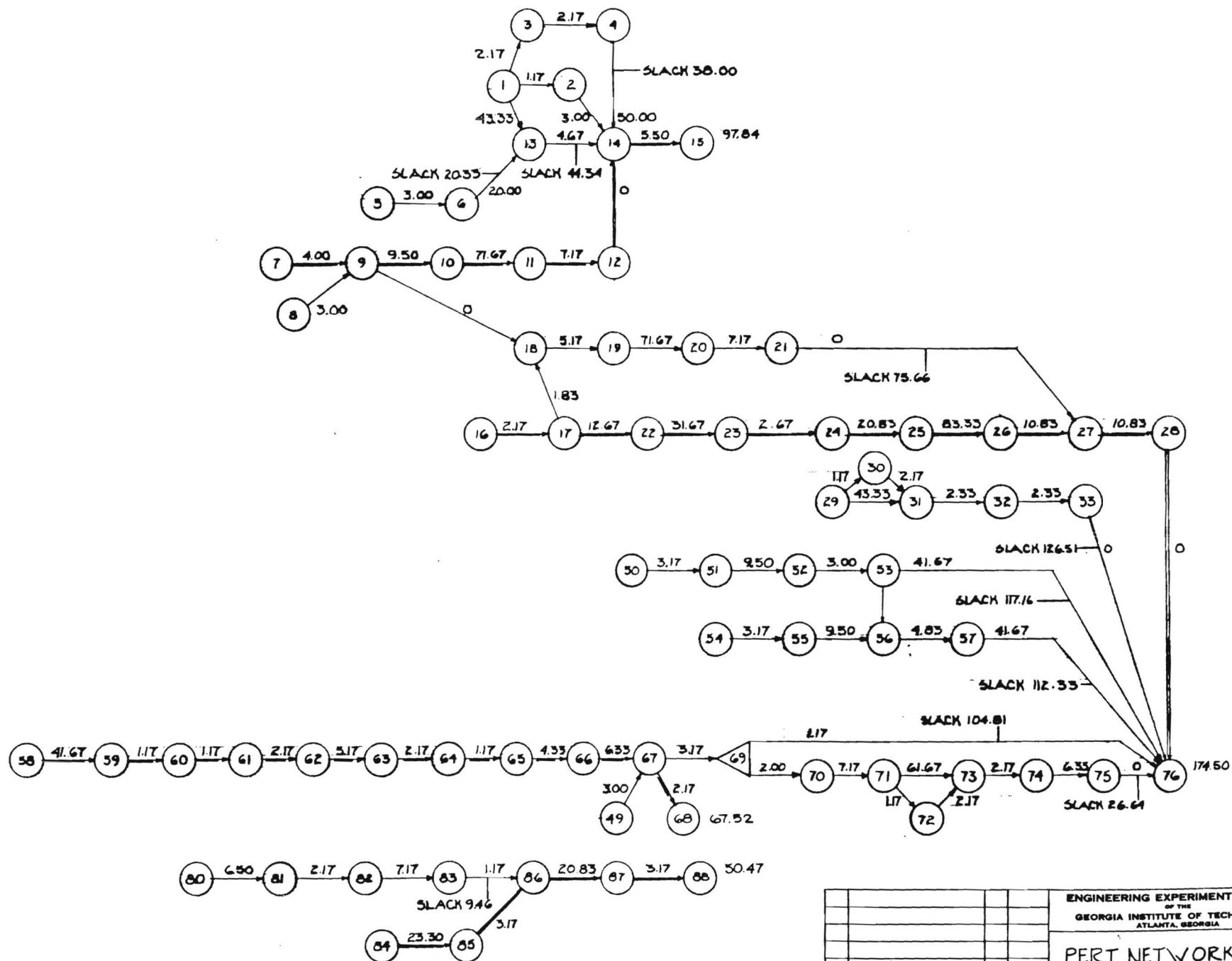
PERT NETWORK

NO.	DESCRIPTION OF CHANGE	CH.	DATE

SCALE: NONE	DATE: OCT 1, 1978	DR. RLR	DRAWING NO.
CONTRACT NO. A-2018-001		ENGR.	
PROJECT NO.		CH.	
		APP.	

PERT EVENTS

No.	Event Description
1.	Ordered injection molding machine
2.	Services for injection molding machine decided upon
3.	Gathered information on peripheral equipment
4.	Ordered peripheral equipment
5.	Start gathering information on plastics materials
6.	Order plastics materials
7.	Start contacting mold makers
8.	Start looking at which handles to mold
9.	Decided on a mold maker
10.	Handle molds designed
11.	Handle molds fabricated
12.	Handle molds debugged
13.	Injection molding machine arrives
14.	Injection molding machine installed
15.	Injection molding machine debugged
16.	Start working on a tip design concept
17.	Decided on a tip design
18.	Tip working drawing complete
19.	Tip mold design complete
20.	Tip mold fabricated
21.	Tip mold debugged
22.	Completed a conceptual design of tipping machine
23.	Completed working drawings of tipping machine
24.	Decided on candidate fabrication contractors
25.	Accepted a quote for fabrication of the tipping machine
26.	Tipping machine fabricated
27.	Tipping machine assembled
28.	Tipping machine debugged
29.	Ordered layout machine and clicker
30.	Decided on services required
31.	Layout machine and chicker arrives

No.	Event Description (continued)
32.	Layout machine and chicker installed
33.	Layout machine and chicker debugged
	34-48 are spares
49.	Transcolorizer services decided upon
50.	Start greige investigation
51.	Greige samples ordered
52.	Greige samples arrive
53.	Greige decision made and order placed
54.	Start film investigation
55.	Film samples ordered
56.	Film samples arrive
57.	Film decision made and order placed
58.	Ordered transcolorizer
59.	Transcolorizer arrives
60.	Drum removed
61.	Drum prepared for coating
62.	Drum arrives at coater
63.	Drum coated
64.	Drum is returned to plant
65.	Drum reinstalled
66.	Transcolorizer serviced and installed
67.	Transcolorizer debugged
68.	Transcolorizer commissioned
69.	Lamination with transcolorized go/no go decision
70.	Adhesive or fusion bonding decision
71.	Lamination machine ordered
72.	Lamination machine services determined
73.	Lamination machine arrived
74.	Lamination machine installed
75.	Lamination machine debugged
76.	Laminating operation commissioned
	77-80 are spares
80.	Start studying office space requirement
81.	Developed alternative designs
82.	Working drawings of office space prepared
83.	Decided on building contractors

No.	Event Description (continued)
84.	Advertised overhead conveyor
85.	Sold overhead conveyor
86.	Accepted a quote
87.	Finished construction
88.	Moved in

PERT ACTIVITIES

No.	Activity Description	Time Estimate		
		O	M	P
1-2	Researching service requirements	1	1	2
1-3	Researching peripheral molding equipment	2	2	3
1-13	Awaiting injection molding machine*	40	40	60
2-14	Installing services	2	3	4
3-4	Evaluating peripheral equipment quotes	2	2	3
4-14	Awaiting peripheral equipment	40	50	60
5-6	Researching plastic raw materials	2	3	4
6-13	Awaiting plastics raw materials	10	20	30
7-9	Evaluating mold makers' proposals	3	4	5
8-9	Deciding which handles to make	2	3	4
9-10	Designing molds	5	10	12
9-18	Dummy	0	0	0
10-11	Fabricating handle molds	60	70	90
11-12	Debugging handle molds	3	5	20
12-14	Dummy	0	0	0
13-14	Installing injection molding machine	2	5	6
14-15	Debugging injection molding machine	2	5	6
16-17	Evaluating tip designs	2	2	3
17-18	Preparing working drawings of tip	1	2	2
17-22	Formulating tipping machine concepts	8	12	20
18-19	Designing tip mold	3	5	8
19-20	Fabricating tip mold	60	70	90
20-21	Debugging tip mold	3	5	8
21-27	Dummy	0	0	0
22-23	Preparing working drawing of tipping machine	20	30	50
23-24	Searching for appropriate contractors	2	2	3
24-25	Awaiting quotes on tipping machine	15	20	30
25-26	Fabricating machine	60	80	120
26-27	Assembling machine	5	10	20
27-28	Debugging machine	5	10	20
28-76	Dummy	0	0	0
29-30	Researching service requirements	1	1	2
39-31	Awaiting layout and chicker machine*	40	40	60

No.	Activities	Time Estimate		
		O	M	P
30-31	Installing services	2	2	3
31-32	Installing layout and chicking machine	2	2	4
32-33	Debugging layout and chicking machine	1	2	5
33-76	Dummy	0	0	0
49-67	Installing services	2	3	4
50-51	Deciding on possible greige materials	2	3	5
51-52	Awaiting greige samples	5	10	12
52-53	Deciding on the greige material	2	3	4
53-76	Dummy	0	0	0
53-67	Awaiting greige	30	40	60
54-55	Deciding on possible plastic films	2	3	5
55-56	Awaiting plastic film samples	5	10	12
56-57	Researching the lamination process	2	5	7
57-76	Awaiting plastic film	30	40	60
58-59	Awaiting transcolorizer*	35	40	55
59-60	Removing drum	1	1	2
60-61	Preparing drum for coating	1	1	2
61-62	Drum in route to coater	1	2	4
62-63	Coating drum	2	4	13
63-64	Drum in route to plant	1	2	4
64-65	Reinstalling drum	1	1	2
65-66	Servicing and installing transcolorizer	3	4	7
66-67	Debugging transcolorizer	3	5	15
67-68	Testing printing function	2	2	3
67-69	Testing laminating function	3	3	4
69-70	Research on process to be employed	1	2	3
69-76	Establishing double duty procedures	1	1	2
70-71	Deciding on a laminating machine	5	7	10
71-72	Formulating services plan	1	1	2
71-73	Awaiting machine	40	60	90
72-73	Installing services	2	2	3
73-74	Installing machine	2	3	3
74-75	Debugging machine	3	5	15
75-76	Dummy	0	0	0
80-81	Developing office space layout	5	6	10
81-82	Preparing working drawings	2	2	3

No.	Activities	Time Estimate		
		O	M	P
82-83	Awaiting quotes	5	7	10
83-86	Evaluating quotes	1	1	2
84-85	Showing overhead conveyor	20	20	40
85-86	Dismanteling overhead conveyor	2	3	5
86-87	Construction in progress	15	20	30
87-88	Moving into office space	2	3	5

*From October 1, 1978

Exhibit 4

GTEES ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

October 9, 1978

Mr. Barney Edelkind
President
Atlanta Umbrella
5340 Panola Industrial Blvd.
Decatur, Georgia 30035

Dear Mr. Edelkind:

This letter is to summarize to date my work on planning the injection molding operation for Atlanta Umbrella Company.

The molding machine you have selected, Cincinnati Milacron 125-12, appears to be adequate for the making of umbrella handles. The tonnage is sufficient since you probably will not have a great deal of molding surface area and the shot capacity may enable you to mold four handles per cycle. The Cincinnati Milacron machine has a very good reputation in the industry and the consumer service rendered by Cincinnati Milacron is widely acclaimed.

At the onset of the planning of your new facility I pursuaded Dr. John Muzzy, director of plastics engineering in the School of Chemical Engineering, to advise you on basic factors concerning manufacturing in plastics. I accompanied him on a visit to your plant during which we discussed both injection molding and extruding. Many things were discussed at this meeting; the most noteworthy of which I will enumerate: He suggested that polypropylene be considered as plastics material and that it be foamed by use of chemical blowing agent on molding. We agreed, after I informed him of the relatively small amount of plastics through-put that a bulk handling system for storing and moving the plastics resin was not feasible. We agreed that blending color concentrate in the feed would be more convenient and economical than pre-colored resin due to the variety of colors you contemplate running. He discovered that the plastic umbrella rods, you had as samples, were not made by extruding since the glass reinforcing fibers were very long and running axially to the rods. He suggested that these rods were made by a pultrusion process.

When I made the plant layout study I allocated a 27' - 6" x 32' - 0" area for the injection molding department. This was to accommodate the one injection molding machine and all its peripheral equipment and provide work space for men and material. Please refer to Area Designation Drawing #AUPL-4 for location of this area in the plant. At the time of making this drawing you had not decided on which peripheral equipment you would be purchasing so a detailed layout of the area was not undertaken.

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An Equal Employment/Education Opportunity Institution

Since this time we both have been in touch with suppliers of peripheral equipment for injection molding machines. I feel the general strategy should be to purchase only those pieces of equipment that are absolutely necessary to get into operation. Once you get into operation more equipment can be added based on a demonstrated need rather than initially purchasing equipment that is unneeded or unsuitable. The factors to be considered when buying this equipment are:

Capacity	– neither too large or too small	
Price	– must be competitive	
Delivery	– nothing over 10 weeks	
Service	– technician available for set up and service	
Guarantee	– repair, replace, or refund if not suitable	

After talking to the vendors you selected and reviewing the literature and specifications on this equipment I suggest you purchase:

1 each; water cooled chiller; Advantage Engineering Corp., #C2W, 2 ton capacity, 460/3/60, for $3,345 with delivery in 6 to 8 weeks

1 each; blender; Thoreson-McCosh, Inc. #ACM224, 4 component blender, 460/3/60, for $2,870 with delivery in 7 to 9 weeks

1 each; loader Thorenson-McCosh, Inc. #VMI, 460/3/60, for $415 with delivery in 7 to 9 weeks

1 each; granulatr; Rapid Gramulator, Inc. #GK 100C, 460/3/60, for $2,945 with delivery in 6 weeks

I do not recommend you buy a dryer/desicator at this time. I realistically expect you will be running polystyrene handles in spite of the conflicting opinions from all sides. There are inherent problems with many of the other candidate plastics materials the least of which is hygroscopic properties. I do agree that polypropylene and ABS have desirable properties for some of the other umbrella handles and components you wish to manufacture but I expect that you will have neither the time or the tooling to get into this for a good many months.

Of late, I have visited both of the mold makers presently under consideration for making molds for your umbrella handles. The concept of design proposed by each is identical: both would use the "Master Unit Die" concept with two to four inserts as applicable, both would use the same mold texturer here in Atlanta. The differences in the two is that the Florida mold maker is accustomed to doing precision work and I would expect his molds to be of very high quality. He would probably be able to make the molds quicker since he is larger and better equipped. The Marietta mold maker appears to be quoting a lower price and there are advantages of his being in the same locality as your plant. You have no need for precision in making umbrella handles. This mold maker is in the custom molding business and understands what is required of a small one machine operation. He would be a

valuable source of assistance in getting your operation off on the right foot, if he is willing and he appears to be willing. The over riding factor in making this decision is how soon do you need the molds. If you can live with a delivery that may be 30% longer than the Florida mold maker you can save money on the cost of the molds by doing business with the Marietta mold maker.

I have touched on many bases with respect to processing foamed plastics on an injection molding machine. There are definite limitations they are:

- o distance of flow from the single point of entry
- o plastic size
- o short size
- o injection speed

Happily the machine you bought has a huge platten size and the shot size is adequate for the parts you will be molding. You still have to contend with a very slow injection rate of 11 cu. in/sec. as compared with foam injection machines on the order of 1000 cu. in/sec. Fortunately the part you are molding has a large cross section which improves the distance of flow problems. The runner design and size will be very important factors in determining the ultimate quality of the product. A standard sprue busing of 1/2" to 3/4" per foot with a minimum "O" dimension of 7/32" is recommended for use in injection machines. The sprues should be as short as practical to minimize effects on polymer flow and injection speed.

Individuals at Cincinnati Milacron are most confident that this foam plastics part can be made to your satisfaction on their machine. In fact, they have commited themselves to working with you on the project.

Your desire to have a four insert cluster with a separate mold cavity in each insert is desirable from a production standpoint. From a tooling con-figuration standpoint it may be somewhat difficult. It appears that the interests for a double "H" standard master die fixture fitting between the tie bars of your machine are too small to accommodate the mold cavity and the coring cam mechanism. Also the attending hoses carrying the cooling water to the mold are going to be a virtual spideweb. Another concern is that the large extensive runner system necessary to make four foamed plastic parts in this arrangement may require more of the shot capacity that you can spare and you won't be able to make four parts anyway. I am not saying that the above is an impossible situation--I am saying that there are difficulties and risks in this approach. If we cannot resolve these pro-blems I suggest you consider a single "H" master die fixture. In which case we may be able to get two cavities in an insert provided the parts are judicious chosen thus giving the capability of molding four parts per cycle. In any event this question must be resolved as soon as possible because these molds require a long lead time and are the current hold up in getting the injection molding operation going.

Several candidates resins have been suggested for the handles i.e., polypropylene, ABS, polystyrene, etc. I recommend impact resistant polystyrene for making the wood-look handles for the following reasons:

> it is least expensive
> it is available from a great many sources
> it is not hygroscopic
> it lends itself to past molding finishing
>   operations, i.e., painting, staining, drilling
> it has a density nearly the same as wood
> it is generally used when a wood-look is desirable
>   e.g., furniture
> it can easily and satisfactorily be glued or
>   adhered to

A decision to use polystyrene is not irrevocable so I suggest that we not agonize over this decision for very long.

To operate this machine efficiently I suggest you need two employees: an unskilled operator and a skilled setup person. The operator will be responsible for attending the machine during <u>continuous</u> automatic cycling. He/she will separate the runners and sprues from the handles and sort the different handles as they are molded. This job requires good manual dexterity and ability to work conscientious at repetitive tasks for hour after hour, day after day. The set-up person must have mechanical skills and be knowledgeable in injection molding operations and equipment. He/she will be responsible for the setup of the mold the feeding of the raw material and trouble shooting the entire operation. He/she can also relieve the operator for his or her breaks and lunch period so that con-tinous operation might be maintained. This person could also be trained on other pieces of equipment in the plant if you desire to get further utilization of him/her.

It is totally impractical to expect the operator and the setup person to be one and the same. There is simply too much for one person to do and the jobs are so vastly different in skill and temperament level that to attempt this would be a disaster.

Separately attached is my estimation of the capital costs; annual cost of the injection molding operation; a background discussion of the standard cost of umbrella handles based on the cost schedules developed for a one, two, and three shift operation.
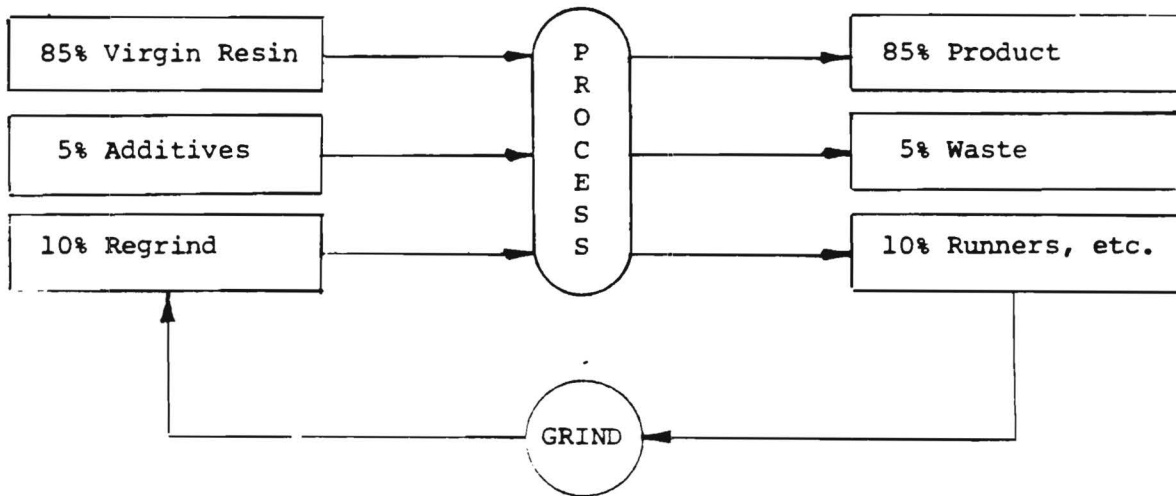
Sincerely,

James C. Muller
Research Engineer

JCM:wc
Attachment

Capital Cost Estimate
Injection Molding Operation
Atlanta Umbrella Company

Equipment $84,075

    Cincinatti Milacron Machine $58,000

    Auxiliary Equipment   11,575
      Blender $2,870
      Grinder   2,945
      Loader   415
      Chiller   3,345
      Misc   2,000

    Peripheral Equipment   14,500
      "A" frame hoist   4,500
      Fork lift   10,000

Other Capitalizable Costs   28,000
  Shipping & Handling   5,000
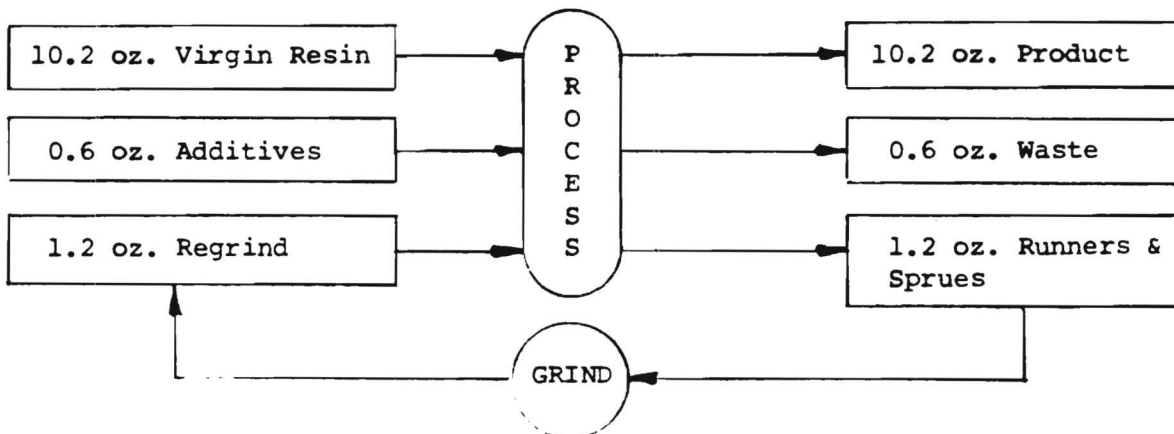 Services installation   5,000
  Tooling   18,000

Total Capital Cost $112,075

Production Model
Injection Molding Operation
Atlanta Umbrella

Assume:

```
┌──────────────────────┐              ┌──────────────────────┐
│  85% Virgin Resin    │─────┐      ┌─│   85% Product        │
└──────────────────────┘     │   P  │ └──────────────────────┘
                             ─┤   R  ├─
┌──────────────────────┐      │   O  │ ┌──────────────────────┐
│   5% Additives       │─────┤   C   ├─│   5% Waste           │
└──────────────────────┘      │   E  │ └──────────────────────┘
                             ─┤   S  ├─
┌──────────────────────┐      │   S  │ ┌──────────────────────┐
│  10% Regrind         │─────┘      └─│  10% Runners, etc.    │
└──────────────────────┘                └──────────────────────┘

              ┌──────────┐
              │  GRIND   │
              └──────────┘
```

Also assume: machine cycles once per minute, that 12 oz. of material
                is processed at each cycle, and that the average umbrella
                handle is 2.7 oz.

Therefore on a per minute basis

```
┌──────────────────────┐              ┌──────────────────────┐
│ 10.2 oz. Virgin Resin│─────┐      ┌─│  10.2 oz. Product    │
└──────────────────────┘     │   P  │ └──────────────────────┘
                             ─┤   R  ├─
┌──────────────────────┐      │   O  │ ┌──────────────────────┐
│  0.6 oz. Additives   │─────┤   C   ├─│   0.6 oz. Waste      │
└──────────────────────┘      │   E  │ └──────────────────────┘
                             ─┤   S  ├─
┌──────────────────────┐      │   S  │ ┌──────────────────────┐
│  1.2 oz. Regrind     │─────┘      └─│  1.2 oz. Runners &   │
└──────────────────────┘                │  Sprues              │
                                        └──────────────────────┘
              ┌──────────┐
              │  GRIND   │
              └──────────┘
```

One Shift Basis*
Annual Manufacturing Cost Estimate
Injection Molding Operation
Atlanta Umbrella Company

Variable Cost $46,332

Labor			$14,500	
Direct labor		$14,000		
One operator	$ 7,000			
1/2 setup man	7,000			
Indirect labor		500		
Material			31,832	
Direct materials		31,132		
Resin	21,453			
Additives	3,321			
Electricity	5,933			
Water	425			
Indirect materials		700		

Fixed Cost   36,849

Identifiable overhead		23,614	
Maintenance services	1,200		
Depreciation	11,207		
Interest on debt	11,207		
Allocated overhead		13,234	
Management salaries	7,548		
Heat, A/C, & light	1,509		
Rent	3,774		
Insurance	252		
General supplies	151		

Total Cost $83,181

*Assuming only injection molding running during second and/or third shift.

Two Shift Basis*
Annual Manufacturing Cost Estimate
Injection Molding Operation
Atlanta Umbrella Company

Variable Cost $101,712

Labor			$35,500
Direct labor		$35,000	
Two operator	$14,000		
1.5 setup man	21,000		
Indirect labor		500	
Material			66,212
Direct materials		64,812	
Resin	46,482		
Additives	7,195		
Electricity	10,285		
Water	850		
Indirect materials		1,400	

Fixed Cost   38,339

Identifiable overhead		23,614
Maintenance services	1,200	
Depreciation	11,207	
Interest on debt	11,207	
Allocated overhead		14,725
Management salaries	7,548	
Heat, A/C, & light	3,000	
Rent	3,774	
Insurance	252	
General supplies	151	

Total Cost $140,051

*Assuming only injection molding running during second and/or third shift.

Variable Cost				$161,224
Labor			$56,500	
Direct labor		$56,000		
3 operator	$21,000			
2.5 setup man	35,000			
Indirect labor		500		
Material			104,724	
Direct materials		102,624		
Resin	75,089			
Additives	11,623			
Electricity	14,637			
Water	1,275			
Indirect materials		2,100		
Fixed Cost				39,839
Identifiable overhead			23,614	
Maintenance services		1,200		
Depreciation		11,207		
Interest on debt		11,207		
Allocated overhead			16,225	
Management salaries		7,548		
Heat, A/C, & light		4,500		
Rent		3,774		
Insurance		252		
General supplies		151		
Total Cost				$201,063

*Assuming only injection molding running during second and/or third shift.

Standard Cost
Injection Molding Operation
Atlanta Umbrella Company

One Shift:

$$\frac{\$\ 83,181}{334,580\ \text{handles}} = \$.2486/\text{handle}$$

Two Shifts:

$$\frac{\$140,051}{724,923\ \text{handle}} = \$.1932/\text{handle}$$

Three Shifts:

$$\frac{\$\ 201,063}{1,171,028\ \text{handle}} = \$.1717/\text{handle}$$

Exhibit 5

Atlanta based umbrella manufacturing plant seeks <u>Plant Manager</u> for its recently expanded operation in Snapfinger Woods Industrial Park. Applicants should have experience in all phases of production management and have directly supervised production personnel. Experience in injection molding and extruding of plastics is desired but not necessary. Salary 18,000 and up, depends on experience. Send resume to Mr. Barney Edelkind, Atlanta Umbrella Company, 5340 Panola Industrial Boulevard, Decatur, Georgia 30035.

Atlanta based umbrella manufacturing company seeks <u>maintenance superintendent</u> for its recently expanded operation in Snapfinger Woods Industrial Park. Applicant should have experience in both electrical and mechanical maintenance in an industrial environment. Additionally, experience with plastic molding and extruding machinery is required. This individual must be willing and competent in carrying out hands-on-fixes of equipment; as well as, supervising the work of others, be they plant personnel or outside contractors. Rewards are exceptionally high for the right individual. Send resume to Barney Edelkind, Atlanta Umbrella Company, 5340 Panola Industrial Boulevard, Decatur, Georgia 30035.

WORLD MARKETS FOR MANUFACTURED PRODUCTS: IMPORT DEMAND AND PROJECTIONS IN THOUSAND UNITED STATES DOLLARS

SIC	SITC	DESCRIPTION
39997000	89941	UNBRELLAS,SUNSHADES

IMPORTING COUNTRY	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976-1980
U S AMER	4338	3514	3810	6138	7528	11617	14076	13777	17942	21577	30066	20591	20664	16772	153711
CANADA	*000000	*000000	756	704	842	1127	1917	1366	1499	441	1164	1119	1068	872	4614
BRAZIL	*000000	*000000	*000000	*000000	*000000	*000000	152	96	199	241	513	439	728	564	3867
MEXICO	66	73	129	219	185	231	204	335	254	225	418	334	669	*000000	4278
BELG LUX	324	316	378	683	800	936	754	838	826	1019	1551	1664	2637	3759	17127
FRANCE	167	171	183	169	290	432	599	797	707	710	1115	1767	2877	4535	21006
GERMNY FED	2724	1449	2014	3191	4312	4746	6754	7374	8822	8607	8501	11678	14457	22940	106716
ITALY	26	38	140	145	281	230	159	374	1088	1716	1852	3128	3592	3197	20968
NETHERLNDS	632	573	1009	1640	1834	1924	1549	2282	2089	2523	2735	3143	4085	4589	26150
UNTD KNGDM	*000000	563	1175	695	1298	1694	1661	1766	2038	3667	6162	5132	4975	9196	44710
DENMARK	329	228	353	403	379	491	448	608	666	657	467	573	764	831	4534
NORWAY	70	131	166	179	153	334	434	559	696	743	727	843	995	1450	8006
SWEDEN	405	335	315	342	266	544	434	334	208	206	237	524	531	1399	54964
AUSTRIA	*000000	*000000	88	194	278	409	317	492	674	750	899	1050	987	1114	7051
PORTUGAL	*000000	0	0	*000000	3	4	30	247	626	76	14	30	40	25	291
SWITZERLND	*000000	83	133	223	409	391	353	382	420	476	601	817	1494	1958	9435
IRELAND	*000000	*000000	*000000	*000000	*000000	*000000	*000000	*000000	*000000	*000000	*000000	67	26	112	748
GREECE	122	213	202	261	264	294	412	448	380	439	453	524	434	392	2824
SPAIN	*000000	141	164	208	287	300	440	553	614	661	936	1657	1713	1709	10943
FINLAND	*000000	*000000	89	77	142	171	92	80	195	153	148	273	367	553	2716
ISRAEL	0	0	1	36	38	57	95	202	124	111	181	461	647	464	2645
AUSTRALIA	*000000	104	90	265	98	196	260	218	285	465	401	457	923	949	A4245
N ZEALAND	2	*000000	2	3	1	1	1	6	6	9	23	28	57	20	180
JAPAN	103	38	9	13	25	19	49	100	86	159	798	4809	6388	7766	39405
SINGAPORE	*000000	*000000	*000000	*000000	*000000	*000000	*000000	605	596	923	830	1588	2405	4216	19636
HONG KONG	544	876	1079	937	1002	790	804	938	1005	1313	1190	2150	1999	2691	13403
KOREA REP	*000000	0	0	0	2	3	4	6	9	0	2	4	51	58	262
THAILAND	*000000	*000000	*000000	*000000	*000000	*000000	659	763	588	571	298	329	260	350	872

*000000 DENOTES MISSING DATA
*1111111 DENOTES MISSING PROJECTIONS (T VALUE NOT SIGNIFICANT AT A CONFIDENCE LEVEL OF .80

55

Exhibit 6

39997000 89941 UMBRELLAS/SUNSHADES

WORLD IMPORT DEMAND COUNTRY	$ VALUE	GROWTH	U S AMERICA MARKET SHARE COUNTRY RANK	$ VALUE	PCT	TREND
GERMNY FED	109716	61	U S AMER	NOT IN TOP 12		
UNTD KNGDM	44710	53	U S AMER	NOT IN TOP 12		
JAPAN	39403	98	U S AMER 9	162	0.41	+
NETHERLNDS	28130	53	U S AMER	NOT IN TOP 12		
FRANCE	21006	91	U S AMER	NOT IN TOP 12		
ITALY	20968	55	U S AMER 6	119	0.57	+
BELG LUX	17137	61	U S AMER	NOT IN TOP 12		
HONG KONG	13403	43	U S AMER 9	3	0.03	-
SPAIN	10943	64	U S AMER	NOT IN TOP 12		
SWITZERLND	9435	76	U S AMER 12	41	0.44	+
NORWAY	8006	68	U S AMER	NOT IN TOP 12		
AUSTRIA	7031	47	U S AMER	NOT IN TOP 12		
SWEDEN	4964	71	U S AMER	NOT IN TOP 12		
CANADA	4614	0	U S AMER 3	688	14.91	=
DENMARK	4534	38	U S AMER	NOT IN TOP 12		
MEXICO	4278	123	U S AMER 2	670	15.66	+
AUSTRALIA	4245	33	U S AMER 6	36	0.86	+
BRAZIL	3867	56	U S AMER 2	600	15.84	+
GREECE	2824	26	U S AMER 12	0	0.02	=
FINLAND	2716	82	U S AMER	NOT IN TOP 12		
THAILAND	872	-51	U S AMER 4	6	0.72	=
IRELAND	748	262	U S AMER 4	14	1.95	+
PORTUGAL	291	54	U S AMER 9	1	0.45	+
KOREA REP	262	123	U S AMER 4	0	0.08	=
N ZEALAND	180	30	U S AMER 6	1	0.60	+
US AMER	154	40				

MAJOR EXPORTING COMPETITORS COUNTRY	$ VALUE	PCT	TREND	MAJOR EXPORTING COMPETITORS COUNTRY	$ VALUE	PCT	TREND
HONG KONG	19294	18.08	+	ITALY	19373	14.41	
KOREA REP	5096	4.78	+	BELG LUX	4734	4.43	
JAPAN	6040	13.51	+	KOREA REP	2418	5.41	
SWEDEN	971	2.17	+	ITALY	803	1.80	
KOREA REP	83444	59.49	+	ITALY	841	2.19	
CHINA MNLD	781	1.98	+	FRANCE	727	1.85	
HONG KONG	6284	24.03	+	JAPAN	3235	12.37	
ITALY	2068	7.91	+	BELG LUX	1895	7.02	
SINGAPORE	3803	18.10	+	HONG KONG	3154	15.02	
GERMNY FED	2029	9.66	+	JAPAN	1076	5.13	
HONG KONG	14990	71.49	+	GERMNY FED	628	3.00	
CHINA MNLD	426	2.03	+	FRANCE	275	1.31	
GERMNY FED	2783	16.25	+	FRANCE	2579	15.06	
NETHERLNDS	2026	11.83	+	JAPAN	1193	6.97	
CHINA MNLD	6499	48.49	+	JAPAN	3947	29.45	
GERMNY FED	194	1.45	+	KOREA REP	103	0.77	
HONG KONG	1726	15.77	+	ITALY	549	5.02	
KOREA REP	257	2.35	+	BELG LUX	212	1.94	
ITALY	2718	28.81	+	HONG KONG	1344	14.46	
JAPAN	1096	11.20	-	GERMNY FED	762	8.08	
FINLAND	691	8.64	+	KOREA REP	454	5.68	
SINGAPORE	447	5.59	+	UNTD KNGDM	348	4.60	
GERMNY FED	956	15.57	+	SWEDEN	844	11.98	
HONG KONG	333	4.73	+	DENMARK	273	3.87	
UNTD KNGDM	508	10.24	+	SWITZERLND	503	10.14	
KOREA REP	462	9.31	+	JAPAN	149	3.00	
HONG KONG	1468	31.81	+	JAPAN	787	17.07	
KOREA REP	96	2.10	+	ITALY	84	1.82	
HONG KONG	608	13.41	+	SWITZERLND	230	5.08	
ITALY	205	4.53	+	KOREA REP	197	4.35	
PANAMA	1976	46.19	+	JAPAN	391	9.15	
KOREA REP	194	4.54	+	HONG KONG	179	4.19	
HONG KONG	1893	44.61	+	JAPAN	1052	24.80	
ITALY	102	2.41	+	UNTD KNGDM	96	2.28	
JAPAN	1307	33.80	+	HONG KONG	469	12.15	
PANAMA	374	9.69	+	UNTD KNGDM	123	3.20	
JAPAN	983	34.81	-	CHINA TAIW	187	6.65	
ITALY	75	2.69	+	HONG KONG	74	2.64	
MALAYSIA	351	12.92	+	HONG KONG	285	10.51	
JAPAN	178	6.56	-	KOREA REP	111	4.10	
JAPAN	125	14.40	-	HONG KONG	81	9.29	
CHINA MNLD	15	1.78	+	KOREA REP	2	0.33	
UNTD KNGDM	356	47.60	+	HONG KONG	275	36.84	
GERMNY FED	26	9.49	+	ITALY	13	3.80	
SWEDEN	50	17.36	+	GERMNY FED	47	16.15	
FRANCE	14	5.03	+	UNTD KNGDM	13	4.64	
JAPAN	214	81.70	+	HONG KONG	2	0.82	
GERMNY FED	0	0.14	-	FRANCE	0	0.04	
JAPAN	101	56.47	+	HONG KONG	39	22.02	
UNTD KNGDM	14	7.97	+	ITALY	6	3.61	

GROWTH DENOTES % CHANGE IN PROJECTED MARKET SHARE COMPARED TO HISTORICAL MARKET SHARE
= TREND DENOTES 76-80 CHANGE IN MARKET SHARE NOT GREATER THAN 2% AND NOT LESS THAN -2%

DRAWINGS
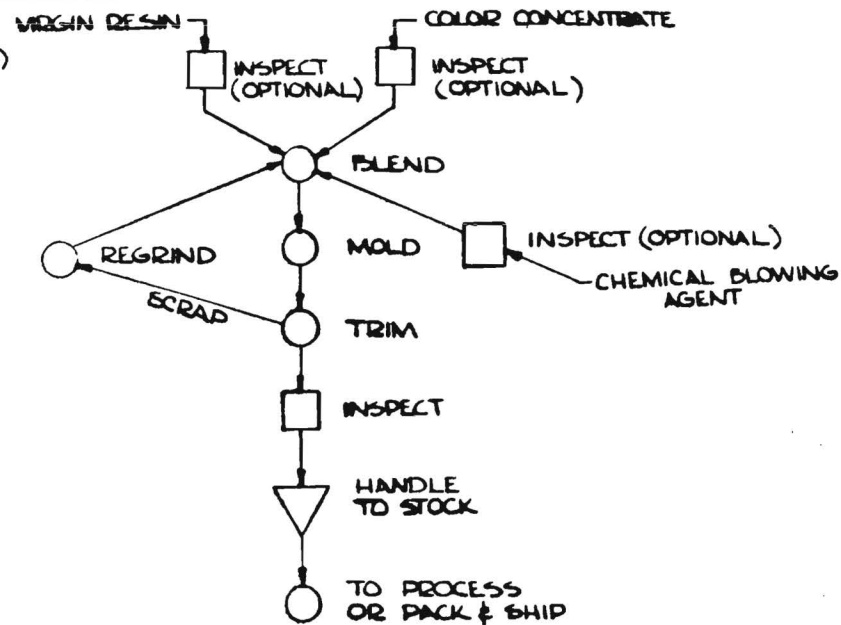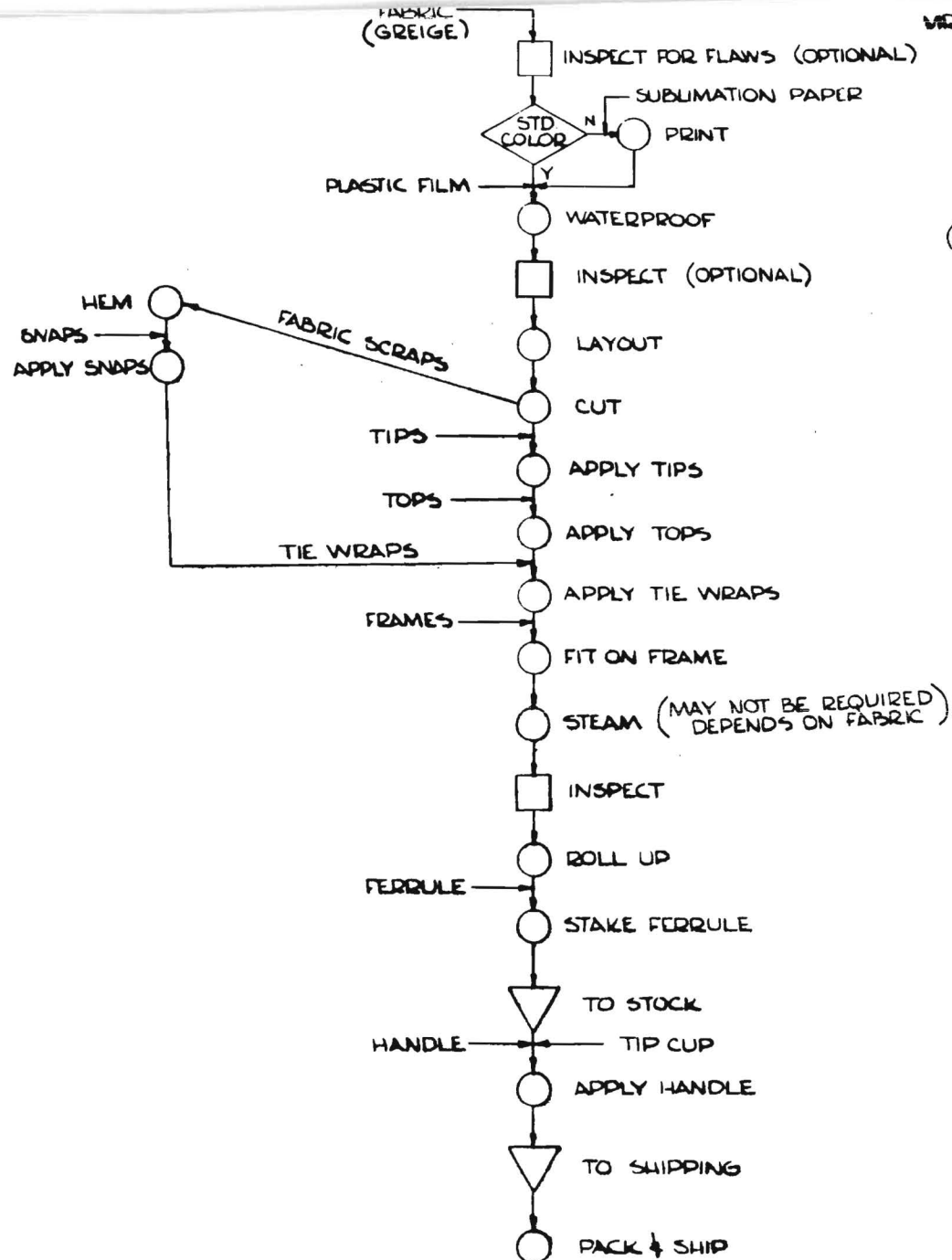
PROCESS CHART
UMBRELLA PLANT

NO.	DESCRIPTION OF CHANGE	CH.	DATE		
SCALE: NONE		DATE: 6-8-78		DR. / ENGR. / CH. / APP.	DRAWING NO. AUPL-1
CONTRACT NO.					
PROJECT NO. A-2018-001					

ENGINEERING EXPERIMENT STATION
OF THE
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA

58

RELATIONSHIP CHART

Activities:
1. LAYOUT & CUTTING
2. MATERIAL STOR. & PLASTICS
3. FABRIC PRINTING
4. FABRIC WATERPROOFING
5. TIPPING
6. TOPPING
7. TIE WRAPS
8. FRAMING
9. STEAMING
10. ROLLING
11. FINISHING
12. SPECIALTY
13. FINISHED GOODS STOR.
14. PLASTICS MAT. STOR.
15. INJECTION MOLDING
16. EXTRUDING
17. FINISHED PLASTICS STOR.
18. BUBBLE MACHINE
19. LOADING DOCKS
20. OFFICE
21. LUNCH ROOM
22. REST ROOMS
23. MAINTENANCE SHOP
24. SHIPPING/RECEIVING

VALUE	CLOSENESS
A	ABSOLUTELY NECESSARY
E	ESPECIALLY IMPORTANT
I	IMPORTANT
O	ORDINARILY CLOSE
U	UNIMPORTANT
X	UNDESIRABLE

CODE	REASON
1	FLOW OF MATERIALS
2	EASE OF SUPERVISION
3	LIGHT
4	NOISE, DISTURBANCE
5	SHARING PERSONEL OR EQUIP.
6	HEAT
7	CONVENIENCE
8	SECURITY
9	DIRT, DUST, GREASE
10	

ENGINEERING EXPERIMENT STATION
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ATLANTA, GEORGIA

RELATIONSHIP CHART

NO.	DESCRIPTION OF CHANGE	CH.	DATE

SCALE: NONE
DATE: 6-8-78
CONTRACT NO.
PROJECT NO. A-2018-001
DR. RLR
ENGR.
CH.
APP.
DRAWING NO. AUPL-2

59

Activity No.	Activity Name	Area Sq.Ft.	Units	Water & Drains	Steam	Compressed Air	Foundations or Pits	Lighting High Intensity	Special Electrical	Fire or Explosion Hazard	Heating	A/C	Special Ventilation	Shape Requirements
		TOTAL 20,200 FT					STANDARD VOWEL RATINGS							
1	LAYOUT & CUTTING 1	476	16					A	O	U	E	A		14 x 34
2	MATERIAL STORAGE EXCEPT PLASTICS	1400						I	U	O	O	O		35 x 40
3	FABRIC PRINTING 1	476						E	A	E	E	A	A	14 x 34
4	FABRIC WATERPROOFING 1	476						I	A	E	E	A	A	14 x 34
5	TIPPING 5	600				A		A	I	U	A	A		10 x 60
6	TOPPING 3	360				A		A	I	U	A	A		10 x 36
7	TIE WRAPS 4	480				A		A	I	U	A	A		10 x 48
8	FRAMING 4	480						E	U	U	A	A		10 x 48
9	STEAMING	561		A	A			O	E	U	O	I		11 x 51
10	ROLLING	400				A		O	U	U	A	A		10 x 40
11	FINISHING 4	480				E		A	E	U	A	A		10 x 48 or 20 x 24
12	SPECIALTY 4	480						A	E	U	A	A		10 x 48 or 20 x 24
13	FINISHED GOODS STORAGE	1,392						I	U	O	O	O		24 x 58
14	MATERIALS STORAGE PLASTICS	400						O	U	O	O	O		20 x 20
15	INJECTION MOLDING	500		A		E		O	A	r	O	O	E	20 x 25
16	EXTRUDING	500		A				O	A	I	O	O	A	20 x 25
17	FINISHED PLASTICS STORAGE	600						O	U	O	O	O		20 x 30
18	BUBBLE MACHINE	225						O	E	O	O	O		15 x 15
19	OFFICE & RESTROOMS	1,400	8					A	O	U	A	A		20 x 70
20	LUNCH AREA	450		A				O	O	O	A	A		15 x 30
21	MAINTENANCE	400				A		A	A	O	A	E		20 x 20
22	SHIPPING / RECIEVING	900				E		E	O	O	E	E		30 x 30

$3.5M/ANNUAL SALES
APPROX. 1M UNITS OR
520 PCS/HR. ASSUMING
8 HR. SHIFT, 5 DAYS A WEEK

12,986 SQ.FT., 66.5%

LEAVES 6,764 SQ.FT. FOR AISLES/CONVEYOR LANES

ENGINEERING EXPERIMENT STATION
OF THE
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ATLANTA, GEORGIA

ACTIVITIES AREA
&
FEATURES SHEET

SCALE: NONE DATE: 6-12-78 DR. RUE ENGR.

CONTRACT NO. A-2018-001

DRAWING NO. AUPL-3

AISLE 6-0 WIDE

SHIPPING AND RECEIVING

EMPLOYEE ENTRANCE

CAFETERIA

FINISHED GOODS STORAGE

30-0

15-0

78-0

AISLE 6-0 WIDE

INJECTION MOLDING

EXTRUDING

MAINTENANCE SHOP

BUBBLE MACHINE

27-0

32-0

32-0

16-0

18-0

AISLE 9-0 WIDE

FINISHING

PACKAGING

PACKAGING MATERIALS

STEAMING & DRYING

ROLLING

FRAMING

SPECIALTY SEWING

TIE WRAPS

TOPPING OPERATION

TIPPING OPERATION

LAYOUT & CUTTING

PLASTICS RAW MATERIAL STORAGE

PIECE GOODS, FASTENING, FRAMES, ETC. STORAGE

PIECE GOODS PROCESSING

AISLE 9-0 WIDE

20-0

18-0

12-0

6-0

20-0

10-0

10-0

10-0

10-0

15-0

50-0

55-0

38-0

25-0

AISLE 9-10 WIDE

ITEM OR FIND NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.	CODE IDENT
		PARTS LIST			

ALL DIMENSIONS ARE IN INCHES
UNLESS OTHERWISE SPECIFIED
TOLERANCES
3 PLACE DECIMALS ±
2 PLACE DECIMALS ±
1 PLACE DECIMAL ±
FRACTIONS ±   ANGLES ± 0°30'
MAX SURFACE ROUGHNESS 125
ALL MACHINED SURFACES
EXCEPT AS NOTED
BREAK SHARP EDGES
AND CORNERS .010 MAX
FINISH

CONTRACT NO.
A-2018-001

DWN
ENGR 7-25-73
CHK
PROD
APVD
APVD

AREA DESIGNATION
PLANT LAYOUT STUDY
ATLANTA UMBRELLA CO.

SIZE D   CODE IDENT NO.   DRAWING NO. AUPL-4

SCALE 1/8-1-0   SHEET

TRANSFORMER

DUNKLE MACHINE
<0 KW
3Φ 4W 240V

4 #6 1EMT

120-208 V
EX PANEL

3Φ BUS LINE

HYDRAULIC
UNIT
10 HORSEPOWER
3Φ 240V

STEAMER

1Φ BUS LINE

NOTES
1. SUSPEND 20 FIXTURES 10'-0"
OFF THE FINISHED FLOOR
2. SUSPEND 3Φ BUS LINE 8'-0"
OFF THE FINISHED FLOOR
3. SUSPEND 1Φ BUS LINE 7'-0"
OFF THE FINISHED FLOOR

25'-10"
9'-10"
5'-0"
15'-0"

55'-0"
73'-0"

3 EQ SP @ 10'-0"
= 30'-0"
5'-0"
14'-0"
2'-0"

62

GEN OFFICE

OFFICE PLAN

PRESIDENT'S OFFICE

UPPER OFFICE PLAN

63

PLANT MAN.

W. LOCKER ROOM

M. LOCKER ROOM

LUNCH ROOM

SALES OFFICE, DISPLAY & CONFERENCE ROOM

RECEPTION

LOWER OFFICE PLAN

APPLICATION					REVISIONS		
QTY PROD	NEXT ASSY	USED ON	ZONE	SYM	DESCRIPTION	DATE	APPROVED

PARTS LIST

ITEM OR FIND NO	QTY REQD		NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.	CODE IDENT.

ALL DIMENSIONS ARE IN INCHES
UNLESS OTHERWISE SPECIFIED

TOLERANCES
3 PLACE DECIMALS ±
2 PLACE DECIMALS ±
1 PLACE DECIMAL ±

FRACTIONS ±   ANGLES ± 0°30'

MAX SURFACE ROUGHNESS 125
ALL MACHINED SURFACES
EXCEPT AS NOTED

BREAK SHARP EDGES
AND CORNERS .010 MAX

FINISH

CONTRACT NO.
A-20-18-001

DWN	RLR	7/13/78
ENGR		
CHK		
PROD		
APVD		
APVD		

OFFICE PLAN
ATLANTA UMBRELLA CO.

SIZE	CODE IDENT NO.	DRAWING NO.	REV
C		ALOU-1	

Atlanta Umbrella Co., Inc.

FRONT ELEVATION

64

SECTION THROUGH PLANT SHOWING OFFICES

ITEM OR FIND NO.	QTY REQD			NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.	CODE IDENT.
			PARTS LIST				

BREAK AREA

SALES OFFICE

WOMEN'S LOCKER R.M.

MEN'S LOCKER R.M.

GEN. OFFICE

WOMEN

MEN

EXECUTIVE OFFICE

UP

ENTRY

OFFICE FLOOR PLAN   SCALE ⅛"=1'-0"

2x4 STUD PARTITION WALL

4'-0"

EXECUTIVE OFFICE

½" DRYWALL ON 1x2 FURRING

½" DRYWALL ON 1" INSULATION ON 1x2 FURRING, EXT. WALL ONLY.

RECEPTION

ALUM. FRAME WINDOW, DBL. GLAZED

3'x7' GLASS DOOR

STEEL PAN STAIR & LANDING

GLASS CURTAIN WALL, DBL. GLAZED

9'-0"   5'   11'-0"

7'-9"

11'-4"

PLAN OF EXECUTIVE OFFICE   SCALE: ¼"=1'-0"

65

Atlanta Umbrella Co., Inc.

FRONT ELEVATION   SCALE: ⅛"=1'-0"

.633 REF.
.545
.478
.400
.100 DIA
.125 DIA
.200 DIA
30°
PARTING LINE
R. SP.
.100
.375
+.000 / -.002
.090 R. SP.
.025 R.

+.002 / .000
.093 R. SP.
.025 SLOT 4 PL. EQ. SP.
+.005 / -.000
.150 DIA
45°
.062
.125 R. SP.
PARTING LINE

NOTES
1. PART MADE OF POLYPROPLENE PLASTICS.
2. MADE BY INJECTION MOLDING.
3. TOLERANCES ±.005 / ± 0° 30' UNLESS OTHERWISE SPECIFIED.

SNAP-ON UMBRELLA TIP
ATLANTA UMBRELLA

NO.	DESCRIPTION OF CHANGE	CH.	DATE

SCALE: 10 X | DATE: 8-25-78 | DR.
ENGR.
CH.
DRAWING NO.
ALIMD 1
CONTRACT NO.

99

March 23, 1979

Mr. Larry R. Edens
Research Engineer
Technology and Development Laboratory
Savannah Area Office
P. O. Box 13817
6606 Abercorn St.
Savannah, Georgia 31406

Dear Larry:

I enclose two copies of our report, "Development of Fire-retardant Chemical Mixes for Cellulose Insulation".

If any technical questions arise as to the content of the report, please contact me (404/428-9055). My recommendations regarding various "chemical-mixes" are contained in the report.

I realize that you were anxious for the report. However, as I explained in my memo of March 8, 1979, there were Federal Bureaucratic delays on their specification requirements, and I had wanted to make some recommendations that would meet all current Federal Regulations.

Sincerely,

Leslie E. Henton
Research Scientist
Chemical and Material Sciences Division

LEH:gp

Development of Fire-retardant
Chemical Mixes for Cellulose Insulation

Mr. Leslie E. Henton
Chemical and Material Sciences Division
Engineering Experiment Station
Georgia Institute of Technology

March , 1979

1. INTRODUCTION

The Chemical and Material Science Division was asked by Mr. Larry R. Edens, Research Engineer, with the Technology and Development Laboratory, Savannah area office, to provide technical assistance to the South Georgia Insulation Manufacturing Co., of Jesup, Georgia.

1.1 Background and Nature of Technical Assistance Required

The company which was established in 1977 manufactures cellulose insulation from waste newsprint. Technical assistance was requested in developing a formula for a flame retardant chemical mix to be used in the process. The company could reduce their raw materials cost, insure product quality, and improve operational consistency by having their own formulation custom-mixed for them. Chemical mixes now being purchased by the company from various suppliers have been causing product quality problems. Their product (cellulose insulation) must meet the new Federal Regulation HHI-515D (Appendix A).

This company was contacted at the request of John Elliott of SBA. Larry Edens met with J. D. Padgett and Rhett Butler to discuss problems related to the selection and evaluation of flame-retardant chemical mixes. The company requested assistance in developing their own mix. Samples of purchased chemical mixes were taken for analysis. The project was submitted for EDA approval.

Larry Edens visited the company to discuss the status of the project and to pick up chemical samples. The samples and related project information were mailed

to Les Henton, Research Scientist, of the Chemical Materials and Science Division. Mr. Henton was assigned to the project to develop a fire-retardant chemical mix for the company. It was decided later to not analyze the products now being used by the company, since these are proprietary products.

As was stated previously, the product (cellulose insulation) must meet Federal Regulation HHI-55ID (Appendix A). However, on August 8, 1978, in the Federal Register, the Consumer Product Safety Commission issued a "Withdrawal of Notice of Proceeding and Establishment of an Interim Safety Standard (Appendix A)".

The Commission believes that an extension of 150 days is necessary to study the technical and scientific basis and safety and economic consequences of the revision. If the Commission is able to complete its work before January 22, 1979, the Commission will publish the proposal at an earlier date. Therefore, in accordance with section 35(c)(2)(c)(ii) of the act, as amended by Pub. L. 95-319, the Commission extends by 150 days, from August 24, 1978 until January 22, 1979, the time in which it must publish the flame resistance and corrosiveness requirements of GSA specification HH-I-515D as a proposed amendment to the interim standard for cellulose insulation at 16 CFR part 1209. In accordance with Pub. L. 95-319, this period may be further extended by the Commission if that becomes necessary.

At the time of writing this report, the CPSC, has not published the flame resistance and corrosiveness requirements for a consumer product safety standard. As we wished to recommend formulations that would meet with all Federal Regulations, we will not be able to at this time. Therefore, the suggested formulations being recommended will need to be examined for their compliance, at the time the regulations are made available, see report of test (Cellulose Insulation), United States Testing Co., Inc., April 25, 1977), "Procedure for Analyzing Fire Retardent Additives", ASTM-E-84 (Standard Test Method for Surface Burning Characteristics of Building Materials),

ASTM C-739 (Standard Specification for Cellulosic Fiber (Wood-Base) Loose-Fill Thermal Insulation), (Appendix A).

2.0 ACTION TAKEN

2.1 Information Survey

2.1.1. Computer Retrieval

Two data bases (Chemical Abstracts CA, National Technical Information Service, NTIS) were searched, using the computer retrieval system of the Information Exchange Center, Price Gilbert Memorial Library. Key terms or words were selected to identify articles and reports that dealt with fire-retardent mixes for cellulosic insulation: Fire-retardant additives, insulation, cellulose, insulation, waste newsprint, flame retardant, chemical mix. Federal Specification HHI-515D, ASTM E-84, ASTM C-739, and insulation, flame retardant chemicals. The number of citations obtained from the Search were 200 of which 19 appeared to be of use for our studies based on titles and key words. Abstracts of thes 19 articles have been included in this report (Appendix B).

2.1.2. Manual Search

"Overview" articles are copied in Appendix B:

(1) "Boron Chemicals Markets Catch Fire", Chemical Week, pp. 29-30 (June 29, 1977)

(2) "How To Make and Install Your Own Insulation", The Mother Earth News, pp-120-121, November/December 1977.

(3) "Ignition Inhibitors for Cellulosic Materials", Journal of Fire Retardant Chemistry, Vol. 5 (February 1978), pp. 42-47.

(4) "Flash-Fire Propensity of Cellulose Insulation Samples Containing Various Borate Fire Retardants". Journal of Fire Retardant Chemistry, Vol. 5 (August 1978), pp. 138-143.

2.1.3. Personal Contacts

U. S. Borax & Chemical Corp.

3075 Wilshire Blvd.

Los Angeles, California 90010

Mr. John Yannacakis

Senior Technical Service Representative

Technical Service & Development

The Forest Product Laboratory

University of Wisconsin

Madison, Wisconsin

Irv Schaffer

3.0   Recommended chemical fire-retardant mixes to be uniform all figures are pounds of chemical per 100 lbs. of cellulosic insulation (shredded news print).

Mixtures:

(1)   Borax - 17.5 lbs.

   Boric Acid - 7.5 lbs.

(2)   Borax - 15.0 lbs.

   Boric Acid - 10.0 lbs.

(3)   Borax - 12.5 lbs.

   Boric Acid - 12.5 lbs.

(4)   Borax - 12.0 lbs.

   Aluminum Sulfate - 25.0 lbs.

(5)   Borax - 15.0 lbs.

   Aluminum Sulfate - 30.0 lbs.

(6)   Borax - 8.75 lbs.

   Boric Acid - 3.75 lbs.

   Ammonium Di-Hydrogen Phosphate - 12.5 lbs.

The above mixtures are roughly in order of increasing fire-retardancy e.g. (1) the least and (6) the most, in relationship to each other. I do feel however, that each of these recommended mixtures, would provide very good fire-retardance. The problem would then be an economical and regulartory one. As the prices of these chemicals vary from week to week, after the mixtures have been determined; that would satisfy all the Federal regulations, the current costs per batch could then be calculated. Additional savings can be garnered by using Borax 5 mol (See Appendic C) to replace regular Borax. The economy of Borax 5 Mol lies in the lower transportation, handling and storage costs of a more concentrated product. Only 76.4 pounds of Borax 5 mol are the equivalent of 100 pounds of regular Borax; hence, the freight and other charges may be reduced by approximately 25%.

APPENDIX A

FEDERAL SPECIFICATION

INSULATION THERMAL (LOOSE FILL FOR PNEUMATIC
OR POURED APPLICATION): CELLULOSIC
OR WOOD FIBER

This specification was approved by the Commissioner, Federal Supply
Service, General Services Administration, for the use of all Federal
agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers chemically treated cellulosic or wood fiber loose
fill thermal insulation for use in attics or enclosed spaces in housing, and other framed
buildings at ambient temperatures, by pneumatic or pouring application. While products
that comply with this specification may be used in various constructions they are adaptable
primarily, but not exclusively, to wood joist, rafters, and stud construction.

1.2 Classification.

1.2.1 Types. Loose fill thermal insulation shall be of the following types, as specified
(see 6.2).

    Type I   - Pneumatic application.
    Type II   - Poured application.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issues in effect on date of invitation for bids or
request for proposal, form a part of this specification to the extent specified herein.

Federal Specifications:

    UU-S-48 - Sacks, Rags, Shipping, Paper, Plastic.
    HH-I-558 - Insulation Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering),
              and Pipe Fitting Covering, Thermal (Mineral Fiber Industrial Type).

(Activities outside the Federal Government may obtain copies of Federal Specifications,
Standards, and Handbooks as outlined under General Information in the Index of Federal Specifi-
cations and Standards and at the prices indicated in the Index. The Index, which includes
cumulative monthly supplements as issued, is for sale on a subscription basis by the Super-
intendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification and other Federal Specifications required by activities
outside the Federal Government for bidding purposes are available without charge from Business
Service Centers at the General Services Administration Regional Offices in Boston, New York,
Philadelphia, Washington, DC, Atlanta, Chicago, Kansas City, MO, Fort Worth, Houston, Denver,
San Francisco, Los Angeles, and Seattle, WA.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and
Handbooks and the Index of Federal Specifications and Standards from established distribution
points in their agencies.)

FSC 5640

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-810 - Environmental Test Methods.

(Copies of Military Specifications and Standards required by contractor in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards:

C 167 - Standard Test Method for Thickness and Density of Blanket or Batt-Type Thermal Insulating Materials.
C 177 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Guarded Hot Plate Standard Test Method for.
C 236 - Thermal Conductance and Transmittance of Built-up Sections by Means of the Guarded Hot Box.
C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

National Motor Freight Traffic Association, Inc., Agent:

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Associations, Inc., Traffic Department, 1616 P Street, N.W., Washington, DC 20036.)

Uniform Classification Committee, Agent:

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

3. REQUIREMENTS

3.1 Material. The insulating material shall be chemically treated cellulosic or wood fibers, or any combination thereof, suitable for pneumatic and pouring application.

3.1.1 Qualification. The loose fill thermal insulation furnished under this specification shall be a product which has been tested and passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable qualified products list (QPL).

3.1.2 Settled density. The settled density shall be determined in accordance with 4.8.1.

3.1.3 Starch. The loose fill insulation shall be tested in accordance with 4.8.9, for starch content. When starch is found to be present in the insulation, the material shall be chemically treated to resist vermin. Test results of the chemical treatment shall be made available to the contracting officer or his representative.

3.1.4 Thermal resistance. The standard thermal resistance values recommended for application are: 13, 19, 24, 32, 40, and are expressed in degree $F-h-ft^2/BTU$ ($M^2.K/W$). The thermal resistance, R, measured, shall be not less than 3.0 per inch thickness and shall average not more than 5 percent below the R value specified for a minimum of four specimens when tested in accordance with 4.8.2.

3.1.5 Moisture absorption. The percent moisture gained in the insulation from exposure to humidity shall be no more than 15 percent by weight when tested in accordance with 4.8.3.

3.1.6 Odor emission. A detectable odor of objectionable nature shall be cause for rejection of the insulation material, when tested in accordance with 4.8.4 and observed by four, or more of the panel members.

3.1.7 Corrosiveness. The loose fill insulation material shall be tested for corrosiveness as specified in 4.8.5. The composition of the insulation material shall be such that after testing, no perforation of the 3 mil metal specimens shall be evident when the specimens are observed over a chrome reflected 40-W appliance light bulb.

3.1.8 Fungi resistance. The loose fill insulation material shall be tested for fungi resistance as specified in 4.8.6. The insulation material shall show no more fungal growth than the control material.

3.1.9 Critical radiant flux. When tested in accordance with the Attic Floor Radiant Panel Test (see 4.8.7), the critical radiant flux of each of the specimens tested shall be equal to or greater than 0.12 W/CM^2. Specimens submitted for the critical radiant flux test shall be blown as specified in the settled density test procedure (see 4.8.1).

3.1.10 Smoldering combustion. When tested in accordance with the smoldering combustion test (see 4.8.8), the insulation shall meet the following requirements:

No evidence of flaming combustion.
Weight loss $\leq$ 15 percent of initial weight, of each of the specimens tested.

3.2 Marking. Each bag of insulation shall be marked to include the following.

(a) Name of manufacturer.
(b) Type of insulation, (pouring or blowing).
(c) Mimimum net weight of insulation per bag.
(d) The manufacturer recommends that the insulation be installed at these minimum thicknesses, maximum coverages, to provide the levels of insulation thermal resistance (R) shown.
(e) Filled-in-table on insulation shall include the following:

TABLE I. Coverage chart

R Value at 75° Mean Temp.	Minimum Thickness	Maximum Net Coverage		Minimum Weight per sq. ft.
To obtain an Insulation Resistance (R) of:	Installed insulation should not be less than:	Bags per 1000 sq. ft. (gross)	Maximum sq. ft. coverage per bag	The weight per sq. ft. of installed insulation should be not less than:
Attic:				
R-40	----inches thick	----bags/MSF	----square feet	----lbs./sq. ft.
R-32	----inches thick	----bags/MSF	----square feet	----lbs./sq. ft.
R-24	----inches thick	----bags/MSF	----square feet	----lbs./sq. ft.
R-19	----inches thick	----bags/MSF	----square feet	----lbs./sq. ft.
R-13	----inches thick	----bags/MSF	----square feet	----lbs./sq. ft.
Sidewalls:				
R-___	----inches thick	----bags/MSF	----square feet	----lbs./sq. ft.

NOTE: The coverage chart shall be based on the settled density as determined in 4.8.1.

(f) Certification: This is to certify that this insulation has been installed in conformance with the above recommendations to provide a value of R-____ using ____ bags of this insulation to cover ____ square feet of area.
(g) Place for builder's signature, company name, and date.
(h) Note: Requirements (f) (g) and (i) may be satisfied by a separate card containing the same information.
(i) Place for applicator's signature, company, name, and date.
(j) Where material is intended for blowing or pouring application, the bag shall have a separate coverage chart for each type of application.

3.2.3 Workmanship. The insulation shall be dry and free of extraneous foreign materials such as metals and glass which will adversely affect its serviceability.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government.

4.2 Classification of inspections. The inspection requirements specified herein shall be classified as follows:

(a) Qualification tests.
(b) Quality assurance inspection.

4.3 Qualification tests. Qualification tests shall be conducted at a laboratory designated by the Federal Supply Service, General Services Administration. Qualification tests shall consist of the tests specified in 4.8.1, 4.8.2, 4.8.3, 4.8.4, 4.8.5, 4.8.6, 4.8.7, and 4.8.8. Failure of any sample to pass any test shall be cause for failure to qualify.

4.4 Sampling for qualification tests. The sample size for qualification shall be as established by the Federal Supply Service, General Services Administration.

4.5 Quality assurance inspection. Quality assurance inspection shall be performed on samples selected in accordance with 4.6.1 and 4.6.2. Examination shall be in accordance with 4.7.1 and 4.7.2. Tests shall be in accordance with 4.9.1, 4.9.2 and 4.9.3.

4.6. Sampling. Each unit of product selected in 4.6.1 and 4.6.2 shall be one filled bag of loose fill insulation.

4.6.1 Sampling for tests. Sampling for tests shall be in accordance with level S-1 of MIL-STD-105. The acceptance quality level (AQL) shall be 2.5 percent.

4.6.2 Sampling for examination. Sampling for examination shall be in accordance with MIL-STD-105, level S-4.

4.7 Examination and tests.

4.7.1 End item. Samples selected in accordance with 4.6.2 shall be examined for defects listed in table II. The AQL shall be 2.5 percent defective. A sample having one or more major defects shall be considered defective.

TABLE II. Classification of defects, end item

Defects	Major
Type not as specified	x
Extraneous materials in the insulation	x
Damp insulation	x
Bags not marked as specified	x

4.7.2 Examination of preparation for delivery. An examination shall be made to determine compliance with the requirements of Section 5. The sample unit shall be one shipping container fully prepared for delivery. Sampling shall be in accordance with MIL-STD-105. The inspection level shall be S-2 with an AQL of 4.0 expressed in terms of percent defective.

4.8 Qualification Test methods. The following tests shall be conducted on materials at the measured settled density: Thermal resistance, moisture absorption, corrosiveness, and smoldering combustion. For radiant panel and smoldering combustion, all material shall be blown prior to testing.

4.8.1 Settled density. Determination of settled density of loose fill insulation shall be in accordance with the following procedure; and the density thus determined shall be the density on which the coverage chart is determined.

APPARATUS

Loose fill insulation sample containers. The sample containers shall be made of construction grade plywood and shall have inside dimensions of 36 inches long by 14 inches wide by 6 inches deep (914.4 x 355.6 x 152.4 mm) and 18 inches long by 14 inches wide by 12 inches deep (457.2 x 355.6 x 304.8 mm) and 11 inches long by 11 inches wide by 6 inches deep (279.4 x 279.4 x 152.4 mm) and 11 inches long by 11 inches wide by 12 inches deep (279.4 x 279.4 x 304.8 mm), plus or minus 1/8 inch.

Depth gauge. The depth gauge shall be as specified in ASTM C 167, Except: the pin shall be 12 inches (304.8 mm) long.

Blowing machine. The blowing machine shall be typical of standard blowing machines and shall be equipped with 100 feet (30.5 M) of 2 inches (50.8 mm), standard flexible blower hose.

Humidity chamber. The humidity chamber shall be capable of maintaining 40°F ± 2°F (4.4°C ± 1.1°C) and 97 percent ± 3 percent relative humidity.

Sample preparation for pneumatic applications. The loose fill sample container shall be located at the same level as the blowing machine on a level floor in front of an operator directing the blowing hose. When blowing, the hose shall be pointed 10 degrees upwards and the end of the hose shall be kept 11 inches above the floor surface for the 6-inch deep containers and 17 inches above the floor surface for the 12-inch deep containers. The air setting shall be selected by conducting a series of tests with the given machine. A minimum of four air settings should be used. Widely different air settings shall be used first. The lowest setting should be that which will give a uniform flow of material and the highest that which will not produce excessive dust. Two intermediate air settings shall then be used. The air setting which produces the minimum or near minimum as blown density shall be used for the actual test. Place the loose fill insulation into the hopper of the blowing machine. When the insulation is blowing at a steady rate, start filling the container so that the main stream of the material is falling over the rear wall slowly move backwards maintaining the height and direction of the flexible hose as specified. Continue filling the container at an even rate until the material falls over the front wall of the container. Screed fluff the insulation to the top of the container, taking care not to compact the insulation or leave large voids in the surface of the material.

Sample preparation for pouring application. Pour loose fill insulation into a simulated attic space until full. The attic space shall be formed by four 8-feet long, 2 x 6-inch joists placed 16 inches on center with 1/2 inch plywood nailed to the ends and bottom. Fluff the material with a 20-inch wide garden rake, applying a series of small amplitude strokes while moving the rake slowly along the joist. Repeat the fluffing process six times, and then with a shovel, place the insulation material into the sample containers.

PROCEDURE

First weigh the empty 36 x 14 x 6 inches (914.4 x 355.6 x 152.4 mm) and 18 x 14 x 12 inch (457.2 x 355.6 x 304.8 mm) containers. Blow or pour the material, as specified in the sample preparation, into four 36 x 14 x 6 inches (914.4 x 355.6 x 152.4 mm) containers, four 18 by 14 by 12 inches (457.2 x 355.6 x 304.8 mm) containers as specified weigh the filled containers and determine the density as blown/poured. Blow or pour two containers 11 by 11 by 6 inches (279.4 x 279.4 x 152.4 mm) and two containers 11 by 11 by 12 inches (279.4 x 279.4 x 304.8 mm) using the same techniques. Measure the thickness with accuracy of at least ± 1/16 inch (1 mm) of the insulation in the center of the container and four additional measurements at locations in each quarter of the container, and calculate the average thickness. Drop the four 36 by 14 by 6 inches (914.4 x 355.6 x 152.4 mm) and the four 18 by 14 by 12 inches (457.2 x 355.6 x 304.8 mm) containers 6 times from 6 inches (152.4 mm) height, making sure containers are dropped flat onto a concrete floor. Measure the thickness with the same accuracy as above in the same spots as used above; determine the average thickness and calculate the percent decrease in thickness during the drop test (designated as S_d). NOTE: There will be a S_d for the 6-inch deep containers and a S_d for the 12-inch deep containers. Place the two 11 by 11 by 6 inches (279.4 x 279.4 x 152.4 mm) filled containers and the two 11 by 11 by 12 inches (279.4 x 279.4 x 304.8 mm) filled containers in a climatic chamber at 40°F ± 2°F (4.4°C) and 97 ± 3 percent relative humidity for 4 days.

Remove the containers from the chamber and place in a conditioned room with climate 73°F + 2°F and 50 + 5 percent relative humidity for at least 3 days. Repeat the 4-day cycle and the 3-day cycle until four 3-day cycles have been completed. The final cycling being 3 days at 73°F + 2°F (22.8°C) at 50 + 5 percent relative humidity. Measure the thickness in the same spots as used above; determine the average thickness and calculate the percent decrease (designated S_c). NOTE: There will be an S_c for the 6-inch deep containers and an S_c for the 12-inch deep containers. Determine the settled density by multiplying the density as blown into 36 x 14 x 6 inches (914.4 x 355.6 x 152.4 mm) and the 18 by 14 by 12 inches (457.2 x 355.6 x 304.8 mm) containers by the factor s = $(100 + S_d + S_c)/100$. The settled densities for the 6 inch (152.4 mm) and the 12-inch (304.8 mm) thick specimens shall be averaged and reported. The drop test and cycling in the climate chambers shall be performed on the pouring application materials in the same manner as for the blown application materials and settled density measurements reported separately.

4.8.2 <u>Thermal resistance</u>. Thermal resistance will be calculated from the thermal conductivity or the thermal conductance as determined in accordance with ASTM C 518. The mean temperature shall be 75°F (23.9°C).

4.8.2.1 <u>Standard reference material</u>. The ASTM C 518 apparatus shall be calibrated using standard reference materials available from the National Bureau of Standards.

4.8.3 <u>Moisture absorption</u>. Determination of the moisture absorption shall be in accordance with the following procedure: at the maximum settled density determined in 4.8.1.

APPARATUS

The test sample container shall be 9 inches by 9 inches by 5 inches deep (232.6 x 232.6 x 127.0 mm).

PROCEDURE

Condition the test specimen at 50 + 2 percent relative humidity and 120°F (48.9°C) to constant weight and record weight. Then increase the relative humidity to 90 + 2 percent and maintain for 24 hours and record weight. Determine the hydration as moisture absorption by weight. (see 3.1.5).

4.8.4 <u>Odor emission</u>. Subject a minimum of 50 g of the material to a soaking temperature of 150°F (65°C) for 30 minutes in a closed container. The container shall be made of stainless steel or glass jars with all-metallic lids. Take care to use containers that will not produce odor. A panel of five persons with normal odor perception shall examine for odor using the following questions: (see 3.1.6).

(a) Was the odor perceptible?
(b) Was the odor objectionable, pleasant or otherwise?
(c) Was the odor weak, strong or very strong?

4.8.5 <u>Corrosiveness</u>. Determination of corrosion shall be in accordance with the following test procedure: (see 3.1.7).

APPARATUS AND MATERIALS:

Humidity chamber capable of maintaining 120° + 1°F and a relative humidity of 97 + 1.5 percent.

Evaporating dishes: Six, glass, 90 mm diameter by 50 mm height.

<u>Test specimens</u>: Two each, 2 by 2 inches (50.8 mm) by 0.003 inch (0.0762 mm) thick metal free of tears, punctures, or crimps as follows:

(1) 3003 bare aluminum, zero temper.
(2) ASTM B 152, type ETP, Cabra No. 110 soft copper.
(3) Low carbon, commercial quality, cold rolled, less than 30 carbon content, shim steel.

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Insulation Sample: Samples of the loose fill thermal insulation submitted for test.

Procedure: Degrease the steel coupons until completely free of water-breaks by scrubbing in 1,1,1-trichloroethane followed by ultrasonic cleaning in a fresh portion of the same solvent for 30 minutes. Rinse in at least two successive portions of distilled water or deionized water (glass containers only) and drain to inspect for water-breaks. Hot air dry. Handle degreased coupons only with clean forceps. Presaturate the insulation samples by mixing 20 grams (gms) of insulation with distilled water. The quantity of distilled water to be used for each 20 g smaple shall be determined using, the following formula:

$$\text{ml distilled water} = \frac{2.5}{\text{determined settled density (pcf)}} \times 150$$

For each 20 g sample of presaturated insulation, place approximately one-half of the insulation sample into an evaporating dish, tamp level, using a clean stainless steel spatula. Place a metal specimen centered on this one-half sample pad in a horizontal plane. Place the remaining half of the presaturated 20 g insulation sample into the evaporating dish on the metal specimen and tamp to assure an even distribution of this material and to assure good contact of the insulation with the metal. Do not cover the evaporating dishes. If dripping occurs in the chamber, position a drip guard in the chamber to divert condensation to the chamber floor. Repeat the above for the six specimens of the 3 mil material. Place all six specimens into the chamber preconditioned to 120°F ± 3°F (49°C) and 97 ± 1.5 percent relative humidity) for 14 days.

Upon completion of the test, thoroughly wash the metal specimens under running water and lightly brush them to remove loose corrosion products. Remove the remaining corrosion products from the copper, aluminum and steel specimens by immersing the test specimens in a solution of 10 parts distilled water and 1 part nitric acid, 15.9 N. The samples shall be immersed in the acid rinse no longer than 30 seconds for any one period between rinsing and light brushing; and shall be immersed no more than twice to remove corrosion products and/or sealed insulation materials.

After cleaning, examine the 0.003 inches aluminum, copper, and steel specimens over a chrome reflected 40 W appliance light bulb for perforation (see 3.1.8).

4.8.6 Fungi resistance. Determination of fungi resistance shall be in accordance with MIL-STD-810, method 508, except the spore suspensions shall be prepared using distilled water. The core of 1/2 inch regular gypsum wallboard shall be used as the control. After the test exposure the test samples shall be examined at 40 X magnification for evidence of fungal growth (see 3.1.8).

4.8.7 Critical radiant flux. Critical radiant flux shall be determine in accordance with the following test procedure: Method of Test for Critical Radiant Flux of Exposed Attic Floor Insulation using a radiant heat energy source, (see 3.1.9).

APPARATUS

The basic elements of the test chamber (Figure 1) are: (1) an air-gas fueled radiant heat energy panel inclined at 30° and directed at (2) a horizontally-mounted attic floor insulation specimen (Figure 2). The radiant panel generates a radiant energy flux distribution ranging along the 100-cm length of the test specimen from a nominal maximum of 1.0 watts/cm^2 to a minimum of 0.1 watts/cm^2. The test is initiated by open flame ignition from a pilot burner. The distance burned to flame-out is converted to watts/cm^2 from the flux profile graph (Figure 8) and reported as critical radiant flux, watts/cm2.

The Radiant Panel Test Chamber shall be Constructed and Instrumentated as follows:

The radiant panel test chamber employed for this test shall be located in a draft-protected laboratory. The radiant panel test chamber, Figures 3 and 4, shall consist of an enclosure 140 cm (55 inches) long by 50 cm (19-1/2 inches) deep by 71 cm (28 inches) above the test specimen. The sides, ends, and top shall be of 1.3 cm (1/2 inch) calcium silicate board, such as Marinite XL, 0.58 g/cm^3 (36 lbs/ft^3) nominal density, with a thermal conductivity @ 200°F of 0.96 cal (g) /hr cm^2 deg C per cm [0.77 Btu/(hr) (ft^2) (deg F per in)]. One side shall be provided with an approximately 10 cm X 110 cm (4 x 44 inches) draft tight fire resistant glass window so that the entire length of the test specimen may be observed from outside the fire test chamber. On the same side and below the observation window is a door which, when open, allows the specimen platform to be moved out for mounting or removal of test specimens. A draft tight fire resistant observation window may be installed at the low flux end of the chamber.

The bottom of the test chamber shall consist of a sliding steel platform which has provisions for rigidly securing the test specimen holder in a fixed and level position. The free, or air access, area around the platform shall be in the range of 1950-3550 cm2 (300-500 square inches). The top of the chamber shall have an exhaust stack with interior dimensions of 12.5 cm (5 inches) wide by 38 cm (15 inches) deep by 30 cm (12 inches) high at the opposite end of the chamber from the radiant energy source. The radiant heat energy source shall be a panel of porous refractory material mounted in a cast iron frame, with a radiation surface of 30.5 X 45.7 cm (12 by 18 inches). It shall be capable of operating at temperatures up to 816°C (1500°F). The panel fuel system shall consist of a venturi-type aspirator for mixing gas and air at approximately atmospheric pressure, a clean dry air supply capable of providing 28.3 NTP m3 per hr (1000 Standard Cubic Feet per Hour) at 7.6 cm (3.0 inches) of water, and suitable instrumentation for monitoring and controlling the flow of fuel to the panel.

The radiant heat energy panel shall be mounted in the chamber at 30° to the horizontal specimen plane. The horizontal distance from the 0 mark on the specimen fixture to the bottom edge (projected) of the radiating surface of the panel is 8.9 cm (3-1/2 inches). The panel to specimen vertical distance is 14 cm (5-1/2 inches) (see Figure 3). The angle and dimensions given above are critical in order to obtain the required radiant flux. The radiation pyrometer for standardizing the thermal output of the panel shall be suitable for viewing a circular area 25.4 cm (10 inches) in diameter at a range of about 1.37 m (54 inches). It shall be calibrated over the black body temperature range of 490-510°C (914-950°F) in accordance with the procedure described in Appendix A. A high impedance potentiometer voltmeter with a suitable millivolt range shall be used to monitor the output of the radiation pyrometer described. The dummy holder (see Figure 5), shall be constructed from heat-resistance stainless steel (ANSI Type 300 (UNA-N08330) or equivalent, thickness 0.198 cm (0.078 inches), having overall dimension of 115 cm (45 inches) by 32 cm (12-3/4 inches) with a specimen opening of 20 cm (7.9 inches) by 100 cm (40 inches). Six slots are cut in the flange on either side of the holder to reduce warping. The holder is fastened to the platform with two stud bolts at each end.

The specimen tray (see Figure 6) shall be constructed from heat-resistant stainless steel (AISI Type 300 (UNA-N08330) or equivalent, thickness 0.198 cm (0.078 inches), having overall dimensions of 110 cm (43.3 inches) by 27.3 cm (10.8 inches) the depth of the tray is 5 cm (2 inches). The flanges of the specimen tray are drilled to accommodate two stud bolts at each end; the bottom surface of the flange is 2.1 cm (0.83 inches) below the top edge of the specimen tray.

The pilot burner, used to ignite the specimen shall be a propane venturi torch with an axially symmetric burner tip having a propane supply tube with an orifice diameter of 0.0076 cm (0.003 inches). In operation, the propane flow is adjusted to give a pencil flame blue inner cone length of 1.3 cm (1/2 inch). The pilot burner is positioned so that the flame generated will impinge on the centerline of the specimen at the 0 distance burned point at right angles to the specimen length (see Figures 3 and 4). The burner shall be capable of being swung out of the ignition position so that the flame is horizontal and at least 5 cm (2 inches) above the specimen plane.

Two 3.2 cm (1/8 inch) stainless steel sheathed grounded junction chromel alumel thermocouples are located in the Flooring Radiant Panel Test Chamber (see Figures 3 and 4). Thermocouples shall be kept clean to insure accuracy of readout. The chamber thermocouple is located in the longitudinal central vertical plane of the chamber 2.5 cm (1 inch) down from the top and 10 cm (4 inches) back from the inside of the exhaust stack. The exhaust stack thermocouple is centrally located 15.2 cm (6 inches) from the top. An indicating potentiometer with a range of 100-500°C (212-932°F) may be used to determine the chamber temperatures prior to a test.

An exhaust duct with a capacity of 28.3-85 NTP m3 per minute (1000-3000 SCFM) decoupled from the chamber stack by at least 7.6 cm (3 inches) on all sides and with an effective area of the canopy slightly larger than the plane area of the chamber with the specimen platform in the out position shall be used to remove combustion products from the chamber. With the panel turned on and dummy specimen in place, there shall be no measurable difference in air flow through the chamber stack with the exhaust on or off.

The dummy specimen which is used in the flux profile determination shall be made of 1.9 cm (3/4 inch) inorganic 0.58 g/cm^3 (36 lbs/ft^3) nominal density calcium silicate board, such as Marinite XL (see Figure 5). It is 25 cm (10 inches) wide by 107 cm (42 inches) long with 2.7 cm (1-1/16 inches) diameter holes centered on and along the centerline at the 10, 20, 30, 40, 50, 60, 70, 80, 90 cm locations, measured from the maximum flux end of the specimen. The total heat flux transducer used to determine the flux profile of the chamber in conjunction with the dummy specimen should be of the Schmidt-Boelter type, have a range of 0-1/5 watts/cm^2 (0-1/32 Btu/ft^2 s), and shall be calibrated over the operating flux level range of 0.10 to 1.5 watts/cm^2 in accordance with the procedure outlined in Appendix A. A source of 15-25°C cooling water shall be provided for this instrument. A high impedance or potentiometric voltmeter with a range of 0-10 m.v. and reading to 0.01 m.v. shall be used to measure the output of the total heat flux transducer during the flux profile determination. A timer shall be used for measuring preheat and pilot contact time.

SAFETY PROCEDURES

The possibility of a gas-air fuel explosion in the test chamber should be recognized. Suitable safeguards consistent with sound engineering practice should be installed in the panel fuel supply system. These may include one or more of the following (1) a gas feed cut-off activated when the air supply fails, (2) a fire sensor directed at the panel surface that stops fuel flow when the panel flame goes out, (3) a commercial gas water heater or gas-fired furnace pilot burner control thermostatic shut-off which is activated when the gas supply fails or other suitable and approved device. Manual reset is a requirement of any safeguard system used. In view of the potential hazard from products of combustion, the exhaust system must be so designed and operated that the laboratory environment is protected from smoke and gas. The operator should be instructed to minimize his exposure to combustion products by following sound safety practice, e.g., insure exhaust system is working properly, wear appropriate clothing including gloves, et al.

TEST SPECIMENS

The test specimen shall be attic floor insulation of sufficient size to fill the specimen tray to a depth of 5 cm (2 inches). Insofar as possible, the attic floor insulation specimen should simulate actual installation practice. Typical examples follow: Loose-fill insulation blown in to fill the tray, then carefully screeded to provide a depth of 5 cm in the tray. Loose-fill insulation poured in to fill the tray, then carefully screeded to provide a depth of 5 cm in the tray. A minimum of three specimens per sample shall be tested.

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Mount the dummy specimen in the mounting frame and attach the assembly to the sliding platform. With the sliding platform out of the chamber, ignite the radiant panel. Allow the unit to heat for 1 hour. The pilot burner is off during this determination. Adjust the fuel mixture to give an air-rich flame. Make fuel flow settings to bring the panel to an apparent black body temperature as measured by the radiation pyrometer, of about 500°C (932°F), and the chamber temperature to about 180°C (356°F). When equilibrium has been established, move the specimen platform into the chamber. Allow 0.5 hours for the closed chamber to equilibrate.

Measure the radiant heat energy flux level at the 40 cm point with the total flux meter instrumentation. This is done by inserting the flux meter in the opening so that its detecting plane is 0.16-0.32 cm (1/16-1/8 inch) above and parallel to the plane of the dummy specimen and reading its output after 30 ± 10 seconds. If the level is within the limits specified, the flux profile determination is started. If it is not, make the necessary adjustments in panel fuel flow. A suggested flux profile data log format is shown in Figure 7.

The test shall be run under chamber operating conditions which give a flux profile as shown in Figure 8. The radiant heat energy incident on the dummy specimen shall be between 0.87 and 0.95 W/cm^2 (0.77 and 0.83 Btu/ft^2 sec) at the 20 cm point, between 0.48 and 0.52 W/cm^2 (0.42 and 0.46 Btu/ft^2 sec) at the 40 cm point and between 0.22 and 0.26 W/cm^2 (0.19 and 0.23 Btu/ft^2 sec) at the 60 cm point. Insert the flux meter in the 10 cm opening following the procedure given above. Read the millivolt output at 30 ± 10 seconds and proceed to the 20 cm point. Repeat the 10 cm procedure. The 30 - 90 cm flux levels are determined in the same manner. Following the 90 cm measurement, make a check reading at 40 cm. If this is within the limits set forth, the test chamber is in calibration and the profile determination is completed. If not, carefully adjust fuel flow, allow 0.5 hours for equilibrium and repeat the procedure. Plot the radiant heat energy flux data as a function of distance along the specimen plane on rectangular coordinate graph paper. Carefully draw the best smooth curve through the data points. This curve will hereafter be referred to as the flux profile curve.

Determine the open chamber apparent black body and chamber temperatures that are identified with the standard flux profile by opening the door and moving the specimen platform out. Allow 0.5 hours for the chamber to equilibrate. Read the radiation pyrometer output and record the apparent black body temperature in °C. This is the temperature setting that can be used in subsequent test work in lieu of measuring the radiant flux at 20 cm, 40 cm, and 60 cm using the dummy specimen. The chamber temperature also shall be determined again after 0.5 hours and is an added check on operating conditions.

CONDITIONING

Test specimens shall be conditioned to equilibrium or a minimum of 48 hours, whichever is greater, at 21 $\pm$ 3°C (69.8 $\pm$ 5.4°F) and a relative humidity of 50 $\pm$ 5 percent immediately prior to testing.

TEST PROCEDURE

With the sliding platform out of the chamber, ignite the radiant panel. Allow the unit to heat for 1 hour. It is recommended that a sheet of inorganic millboard be used to cover the opening when the hinged portion of the front panel is open and the specimen platform is moved out of the chamber. The millboard is used to prevent heating of the specimen and to protect the operator. Read the panel apparent black body temperature and the chamber temperature. If these temperatures are in agreement to within $\pm$ 5°C with those determined previously, as above, the chamber is ready for use.

Mount the specimen tray with insulation on the sliding platform and position with stud bolts (see Figure 9). Ignite the pilot burner, move the specimen into the chamber, and close the door. Start the timer. After 2 minutes preheat, with the pilot burner on and set so that the flame is horizontal and 5 cm above the specimen, bring the pilot burner flame into contact with the center of the specimen at the 0 cm mark. Leave the pilot burner flame in contact with the specimen for 5 minutes, then remove to a position 5 cm above the specimen and leave burning until the test is terminated.

If the specimen does not ignite within 5 minutes following pilot burner flame application, the test is terminated by extinguishing the pilot burner flame. For specimens that do ignite, the test is continued until the flame goes out. When the test is completed, the door is opened, the specimen platform is pulled out.

Measure the distance burned, i.e., the point of farthest advance of the flame front, to the nearest 0.1 cm. From the flux profile curve, convert the distance to watts/cm2 critical radiant heat flux at flame out. Read to two significant figures. A suggested date log format is shown in Figure 10. Remove the specimen tray from the moveable platform. The succeeding test can begin as soon as the panel apparent black body temperature and chamber temperature are verified. The specimen tray should be at room temperature prior to insertion of the next specimen.

4.8.8 <u>Smoldering combustion</u>. Smoldering combustion shall be determined in accordance with the following test procedure: Method of Test for Smoldering Combustion Characteristics of Materials Used for Thermal Insulation, (see 3.1.10).

APPARATUS

The specimen holder shall be an open-top 20 $\pm$ 0.2 cm square box, 10 $\pm$ 0.2 cm in height, fabricated from a single piece of 0.61 $\pm$ 0.08 mm thick (24 U.S. Standard gauge) stainless steel sheet with the vertical edges of the box overlapped, not to exceed to 7 mm in seam width, and soldered so as to be watertight. The specimen holder during test use shall rest upon a pad of glass fiberboard having dimensions equal to or greater than those of the bottom of the specimen holder. The glass fiberboard shall be approximately 2.5 cm thick with a density of 40 $\pm$ 8 kg/m3 (Note 1). NOTE 1: Glass fiberboard which meets Federal Specification HH-I-558B (Form A, Class 1, plain faced) is suitable for this purpose.

<u>Ignition source</u>. The ignition source shall be a cigarette without filter tip made from natural tobacco, 85 $\pm$ 2 mm long with a tobacco packing density of 0.270 $\pm$ 0.020 g/cm3 and a total weight of 1.1 $\pm$ 0.1 gm.

Balance. A balance of 1 kg capacity, accurate at least to 0.1 g, and provided with a suitable scale pan is required.

Test area. The test area shall be draft-protected and equipped with a suitable system for exhausting smoke and/or noxious gases produced by testing. Air velocities as measured by a hot wire anemometer in the vicinity of the surface of the sample shall not exceed 0.5 m/sec. The test area shall be maintained at 21 ± 3°C (69.8 ± 5.4°F) and 50 ± 5 percent relative humidity.

TEST PROCEDURE

Samples and cigarettes shall be conditioned in air at a temperature of 21 ± 3°C (69.8 ± 5.4°F) and a relative humidity of 50 ± 5 percent for at least 48 hours prior to test. Samples and cigarettes shall be removed from any packaging and exposed in a suitable manner to permit free movement of air around them during conditioning. Calculate the weight of material necessary to fill the holder (volume 44, 0.14 ft3) at the settled density as determined in 4.8.1. The material shall be loaded uniformly into each specimen holder, level and flush to the top edge of the holder. The weight of each specimen shall be measured to the nearest 0.2 g or less by weighing the holder before and after filling. If the weight of the specimen is less than that calculated, the loaded holder shall be dropped from a height no greater than 3 inches (7.6 cm) onto a hard flat surface and additional material added up to the top edge of the holder. This process shall be repeated until the calculated weight of material has been added and completely fills the holder. With the sample in the holder and placed on the insulated pad, a rod of 8 mm diameter with a pointed end shall be inserted vertically into the approximate center of the material being tested and withdrawn to form an appropriate cavity for the ignition source, such that the cigarette fits snugly and maintains uniform contact with the specimen. A well lit cigarette, burned not more than 8 mm (0.3 inch), shall be inserted using tweezers in the formed cavity, with the lit end upward and flush with the sample surface. Burning of the cigarette and specimen shall be allowed to proceed undisturbed in the test area for at least 2 hours or until the smoldering is no longer progressing.

After completion of burning and after the holder has cooled down to 25°C, the specimen holder with its material residue shall be weighed, at least to the nearest 0.2 g, and the percent weight loss of the original specimen calculated. The weight of the cigarette residue is ignored in this calculation.

4.8.9 Starch. Determination of the starch shall be in accordance with the following qualitative procedure:

REAGENT

Make a 1.3 g/litre stock solution of iodine (I_2) by dissolving 0.13 g of I_2 in a solution of 2.6 g of potassium iodide (KI) in 5 ml of water and diluting to 100 ml. Dilute a portion of this to a pale yellow color by mixing 1 volume of stock solution with 9 volumes of water each time a test for starch is made.

PROCEDURE

Boil 0.5 g of the paper specimen for several minutes with 10 ml of water. Filter, cool the filtrate, and add 1 drop of iodine solution. Observe the color. A blue coloration is conclusive evidence of the presence of starch in the paper, (see 3.1.3).

4.9 Quality Assurance test methods.

4.9.1 Critical radiant flux. Critical radiant flux shall be determined in accordance with 4.8.7.

4.9.2 Smoldering combustion. Smoldering combustion shall be determined in accordance with 4.8.8.

4.9.3 Thermal resistance. Thermal resistance shall be calculated from the thermal conductivity or the thermal conductance as determined in accordance with ASTM C 177, C 236 or C 518. The mean temperature shall be 75°F (23.9°C). (See 4.8.2.1).

5. PREPARATION FOR DELIVERY

5.1 Packing. The packing shall be level A or commercial as specified (see 6.2).

5.1.1 Level A. Insulation shall be packed in bags conforming to UU-S-48 6-6X (1) or a polyethylene bag of equal moistureproof and bursting strength. The gross weight shall not exceed 45 pounds.

5.1.2 Commercial. The insulation shall be packed in accordance with normal commercial practice and packed to assure acceptance by common carrier and provide product protection against loss and damage during multiple shipments, handling and storage. The shipping containers shall be in accordance with National Motor Freight Classification and Uniform Freight Classification.

5.2 Marking. Marking shall be as specified in the contract or order.

6. NOTES

6.1 Intended use. The loose fill insulation covered by this specification is intended for use as thermal insulation in housing and buildings.

6.2 Ordering data. Purchasers should select the preferred options permitted herein, and include the following information in procurement documents:

(a) Title, number, and date of this specification.
(b) Type (see 1.2).
(c) Level of packing required (see 5.1).
(d) Thermal resistance (R) value required shall be specified (see table I).
(e) Minimum net weight of insulation per bag required. (see 5.1.1).

6.3 Thermal resistance R value. R is the reciprocal of the thermal conductance (c) and can be calculated as follows:

$$R = \frac{1}{C} = \frac{T}{K}$$

Where: T = Thickness of insulation in inches.
K = Thermal Conductivity Value in BTU in./hr. sq. ft. °F at 75°F mean temperature.
C = Thermal Conductance Value in BTU/hr. sq. ft. °F.

MILITARY CUSTODIANS:	Military Coordinating Activity:
Navy - YD	Army - ME
Air Force - 84	
Review activities:	Preparing Activity:
Navy - YD	GSA - FSS
Air Force - 84	
User activities:	Civil Agency Coordinating Activities:
Army - ME	COMMERCE - NBS
Navy - YD	GSA - FSS, PCD
Air Force - 84	HUD - TCS - DOE - FTC
	CPSC

Figure 1

Figure 2

14
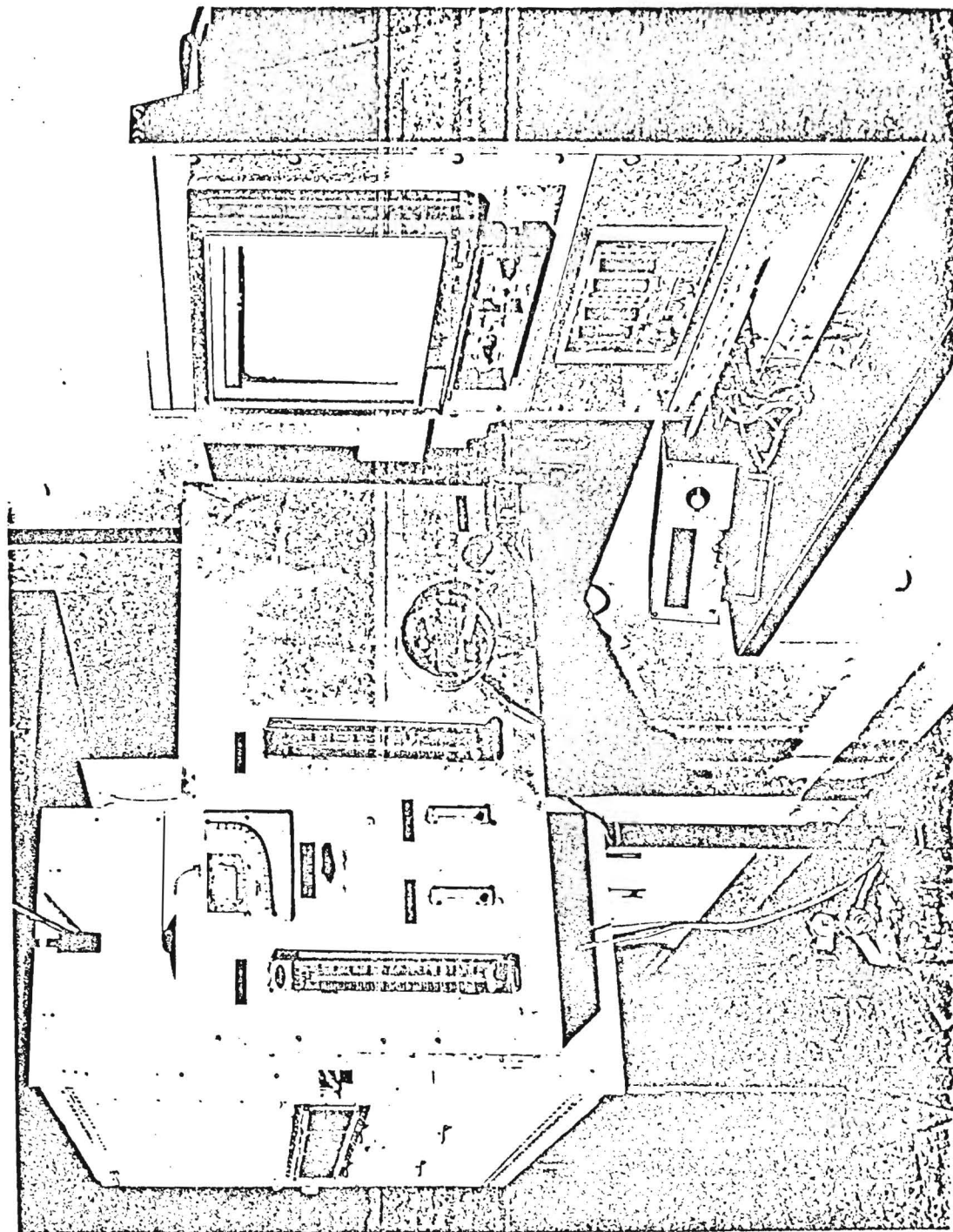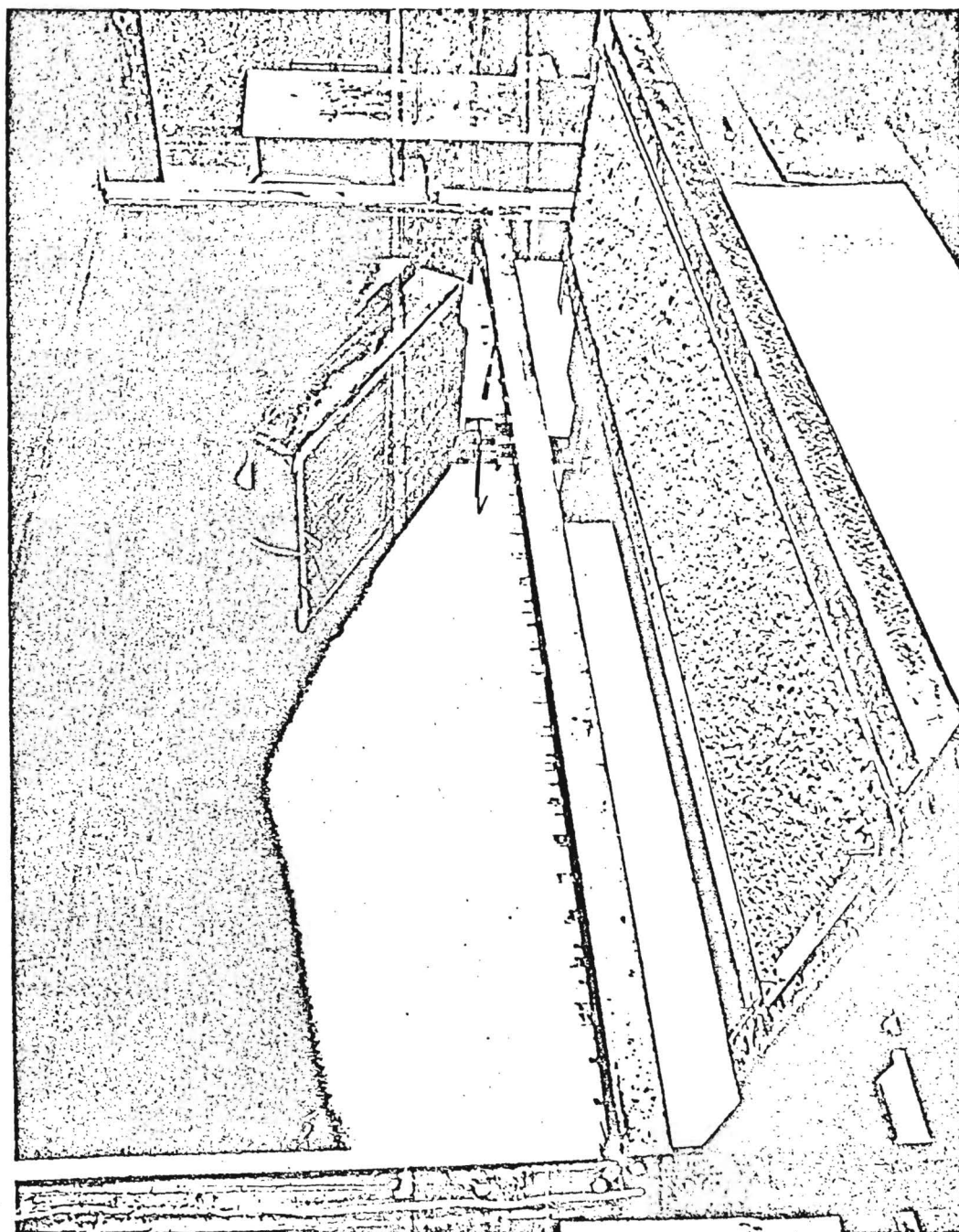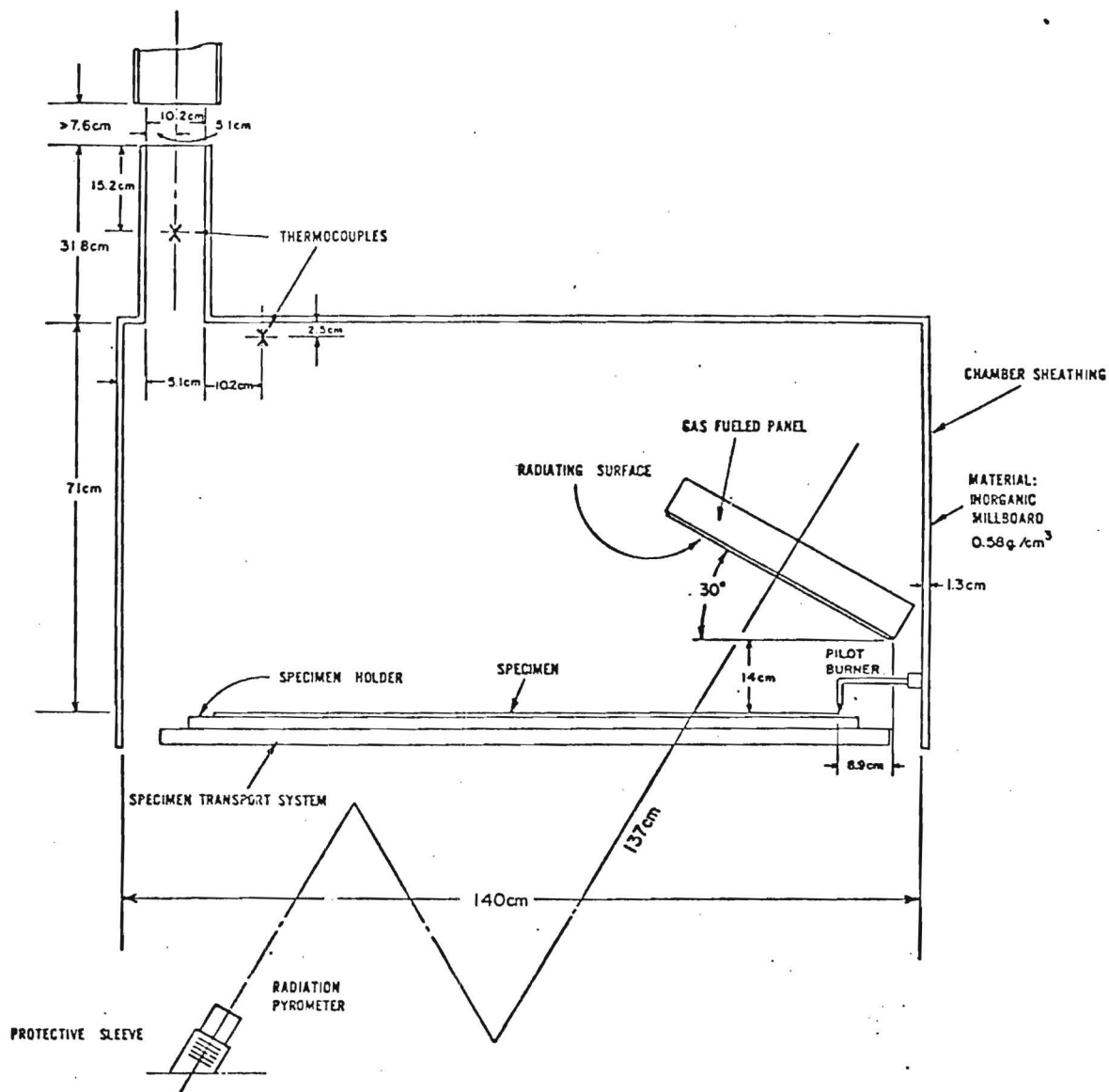
FLOORING RADIANT PANEL TESTER SCHEMATIC
SIDE ELEVATION

Figure 3
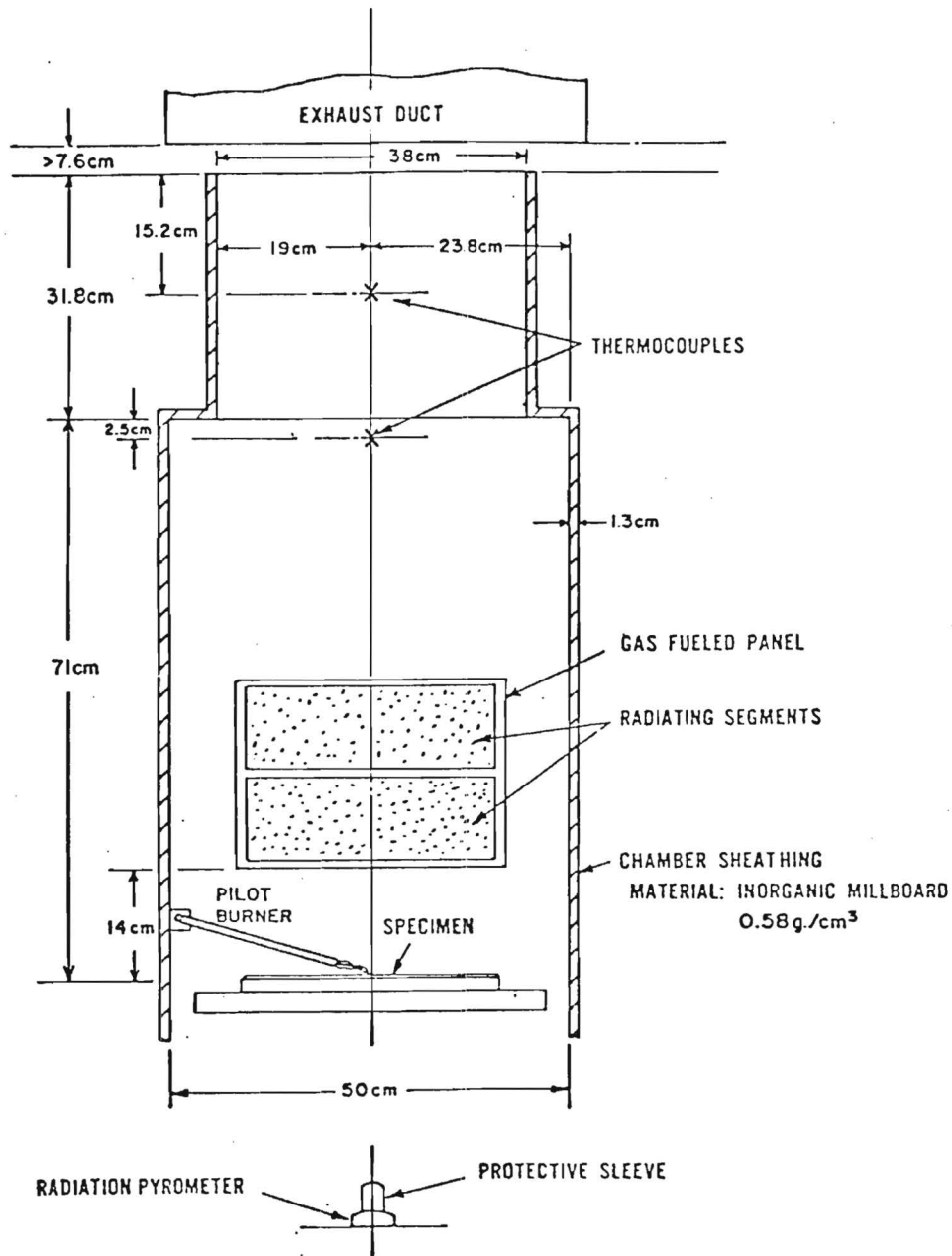
FLOORING RADIANT PANEL TESTER SCHEMATIC
LOW FLUX END, ELEVATION

Figure 4

DUMMY SPECIMEN
MATERIAL: INORGANIC MILLBOARD
0.58 g./cm³

SPECIMEN HOLDER
MATERIAL: STAINLESS STEEL
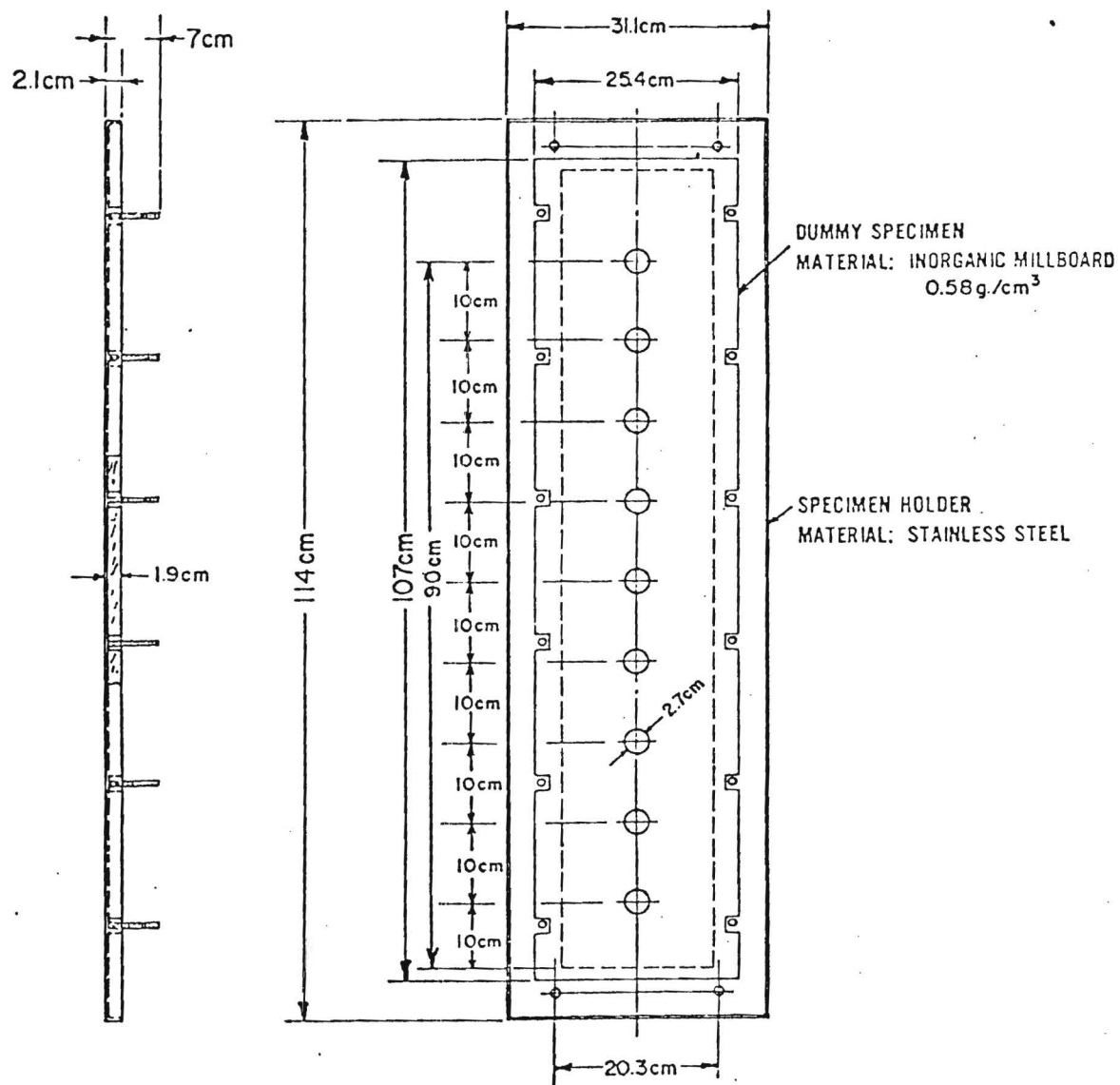
DUMMY SPECIMEN IN SPECIMEN HOLDER

Figure 5

SPECIMEN TRAY

Figure 6

18
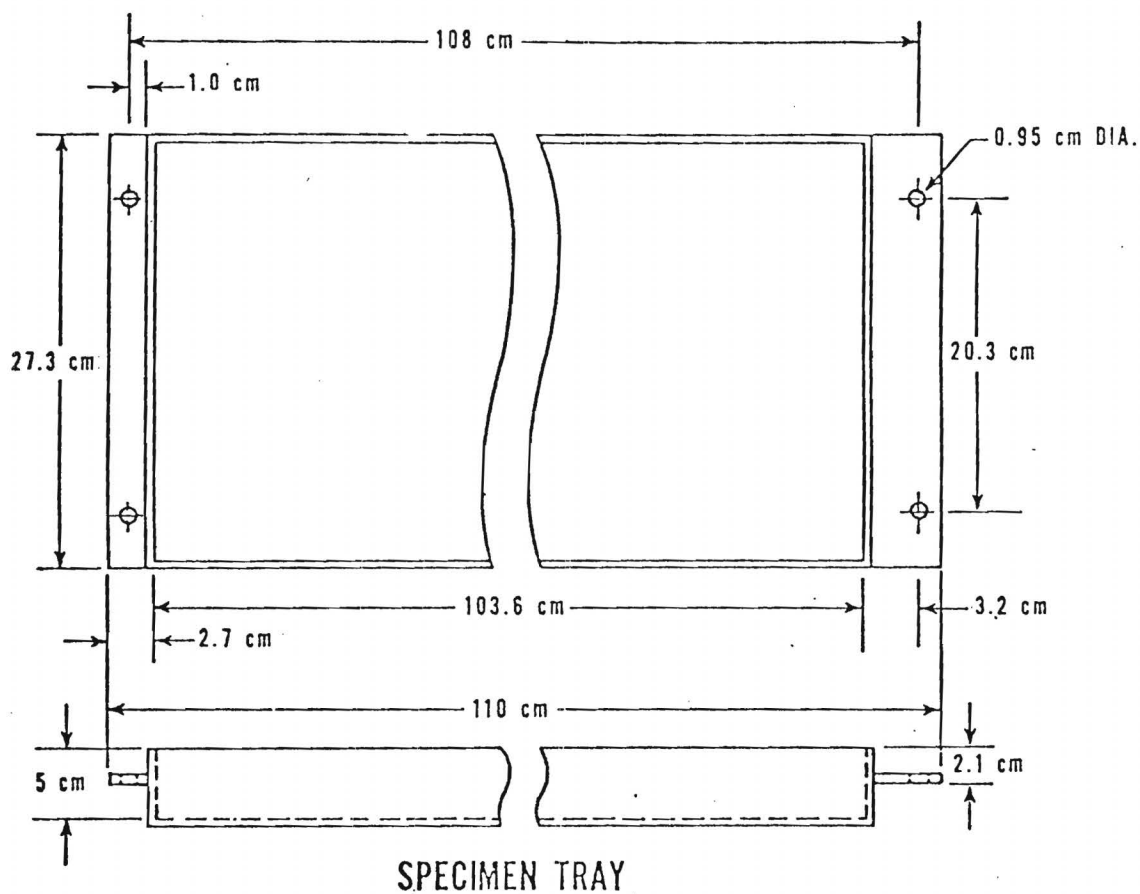
RADIANT FLUX PROF*

Date_____

Black Body Temperature_____m.v.   _____°C (°F)

Gas Flow_____NTPm³H (SCFH)   Air Flow_____NTPm³H (SCFH)

Room Temperature_____°C (°F)

Air Pressure _____   Gas_____cm (in) of H₂O

Flux Meter   Conversion Factor_____

Radiometer No._____   from Calibration on_____

Distance (cm)	MV	Watts/cm²
10	_____	_____
20	_____	_____
30	_____	_____
40	_____	_____
50	_____	_____
60	_____	_____
70	_____	_____
80	_____	_____
90	_____	_____

Signed _____

Figure 7. Flux Profile Data Log Format

OPERATING CONDITIONS
BLACK BODY TEMPERATURE 490C
CHAMBER TEMPERATURE, BOTTOM
    OPEN 171C
GAS FLOW (96% METHANE) 1.1 m3 per hr.
AIR FLOW 16.4 m3 per hr.
(PROFILE DETERMINED AT EQUILIBRIUM,
 CHAMBER CLOSED, DUMMY SPECIMEN IN
 PLACE)
INSTRUMENTATION
TOTAL HEAT FLUX METER - MEDTHERM
MODEL No. 64-2-20, SERIAL No. 124421
(CALIBRATED AT NBS BY OPTICAL RADIATION
 GROUP 8-29-74)
DIGITAL VOLTMETER - KIETHLEY MODEL
 No. 160 RANGE USED 0-10 mV.
PANEL
No. 1 RADIANT BURNER 30.5 × 45.7 cm
RADIANT HEATING Ltd. PATTERN
No. 2458 NBS P.O. S - 402857 - 74
INSTALLED 9-3-74

STANDARD RADIANT HEAT ENERGY FLUX PROFILE

Figure 8

DUMMY HOLDER

10 cm | 10 cm
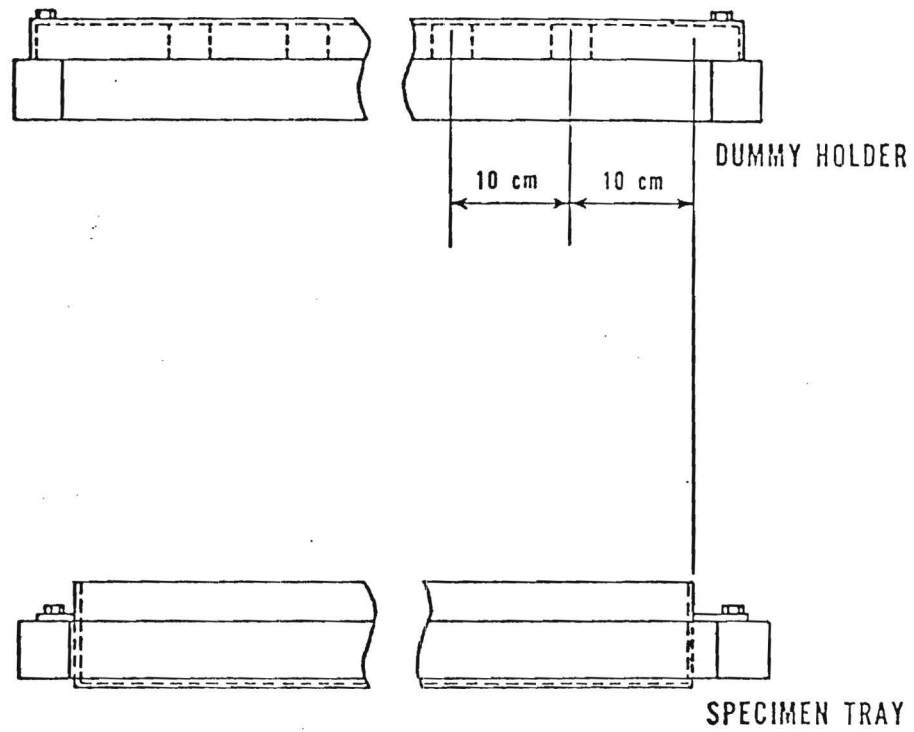
SPECIMEN TRAY

SPECIMEN TRAY MOUNTING POSITION

Figure 9

Test Number _____ Date _____ Time _____

Laboratory _____

Specimen Identification/Code No. _____

Test Assembly: _____

Panel: Angle _____° Temperature _____°C (°F)

Flow: Gas _____NTPm³H (SCFH) Air _____NTPm³H

Pressure, cm (in) H₂0: Initial, Air _____ Gas _____

Chamber Temperature (Initial) _____°C (°F)

Room: Temperature _____°C (°F) Hood Draft _____cm (in) water

Flame Front Out _____ min.

All Flame Out _____ min.

Total Burn Length _____cm (in)

Critical Radiant Flux watts/cm² _____

Flux Profile Reference _____

Observations:

Signed _____

Figure 10. Insulation Radiant Panel Test Data Log Format

APPENDIX A

PROCEDURE FOR CALIBRATION OF RADIATION INSTRUMENTATION

Radiation pyrometer

Calibrate the radiation pyrometer by means of a conventional black body enclosure placed within a furnace and maintained at uniform temperatures of 490, 500, and 510°C (914, 932, 950°F). The black body enclosure may consist of a closed chromel metal cylinder with a small sight hole in one end. Sight the radiation pyrometer upon the opposite end of the cylinder where a thermocouple indicates the black body temperature. Place the thermocouple within a drilled hole and in good thermal contact with the black body. When the black body enclosure has reached the appropriate temperature equilibrium, read the output of the radiation pyrometer. Repeat for each temperature.

Total heat flux meter

The total flux meter shall be calibrated by the National Bureau of Standards, (Direct request for such calibration services to the: Optical Radiation Section, 232.04, National Bureau of Standards, Washington, DC 20234.), or alternatively, its calibration shall be developed by transfer calibration methods with an NBS calibrated flux meter. This latter calibration shall make use of the radiant panel tester as the heat source. Measurements shall be made at each of the nine dummy specimen positions and the mean value of these results shall constitute the final calibration.

It is recommended that each laboratory maintain a dedicated calibrated reference flux meter against which one or more working flux meters can be compared as needed. The working flux meters should be calibrated according to the procedure of A2.1 at least once per year.

federal register

CONSUMER PRODUCT SAFETY COMMISSION

CELLULOSE INSULATION STANDARD

Withdrawal of Notice of Proceeding and Establishment of Interim Safety Standard

[6355-01]

CONSUMER PRODUCT SAFETY COMMISSION

CELLULOSE INSULATION

Withdrawal of Notice of Proceeding to Develop a Standard; Extension of Time To Propose an Amendment to the Interim Standard

AGENCY: Consumer Product Safety Commission.

ACTION: Notice of withdrawal of notice of proceeding to develop a standard; notice of extension of time for proposing an amendment to the interim standard.

SUMMARY: In this notice the Commission withdraws a March 13, 1978 notice of proceeding to develop a consumer product safety standard for cellulose insulation. The Commission takes this action because, as required by legislation enacted on July 11, 1978, the Commission has issued an interim safety standard for cellulose insulation, which is published elsewhere in this FEDERAL REGISTER; therefore, the Commission's proceeding to develop a standard is unnecessary.

In this notice, the commission also extends, for 150 days, from August 24, 1978 until January 22, 1979, the time in which it must publish a revised GSA specification as a proposed amendment to the interim standard for cellulose insulation. The July 11, 1978 legislation requires the Commission to propose the amendment by August 24, but allows the Commission to extend the time. The Commission is extending the time for proposing an amendment to the interim standard, in order to further study the technical and scientific basis and safety and economic consequences of the revised GSA specification.

DATES: The time for the Commission to publish a proposed amendment to the interim standard is extended from August 24, 1978 until January 22, 1979.

FOR FURTHER INFORMATION CONTACT:

Philip Bechtel, Office of the General Counsel, Consumer Product Safety Commission, Washington, D.C. 20207, 202-634-7770.

SUPPLEMENTARY INFORMATION:

WITHDRAWAL OF NOTICE OF PROCEEDING TO DEVELOP A STANDARD

The Commission began a proceeding to develop a consumer product safety standard for cellulose home insulation under section 7 of the Consumer Product Safety Act (CPSA) (15 U.S.C. 2056) by a notice in the FEDERAL REGISTER of March 13, 1978 (43 FR 10427) in which the Commission invited any interested person to submit either (1) an offer to develop a recommended consumer product safety standard or (2) an existing standard to serve as a recommended consumer product safety standard. The Commission began this proceeding after it preliminarily determined that fire hazards associated with cellulose home insulation constitute unreasonable risks of death or injury and that a consumer product safety standard is necessary to eliminate or reduce those unreasonable risks. In response to the notice of proceeding, the Commission received nine submissions from interested persons by the due date of April 12, 1978, and two submissions after that date. In a notice published in the FEDERAL REGISTER of May 9, 1978 (43 FR 19905) the Commission extended from May 12, 1978 until August 31, 1978 the period for it to evaluate the offers and decide whether to accept an offer to develop a recommended standard. The Commission extended the time because legislation was pending in Congress to require the Commission to publish within a short period of time an interim consumer product safety standard.

On July 11, 1978 this legislation became law (Pub. L. 95-319) requiring the Commission to publish an interim standard by August 24, 1978. The legislation provides that the interim standard is to consist of the requirements for flame resistance and corrosiveness from the General Services Administration (GSA) specification for cellulose insulation (HH-I-515C) and any technical nonsubstantive changes the Commission wishes to make in these provisions. In a notice published elsewhere in this issue of the FEDERAL REGISTER the Commission has published the interim standard (16 CFR part 1209). Because the interim standard contains requirements to help eliminate or reduce an unreasonable risk of injury to consumers from flammable or corrosive cellulose insulation, the Commission does not believe that it is necessary to continue its own proceeding under section 7 of the CPSA. In addition, Pub. L. 95-319 requires the Commission to propose within a short time period, as amendments to the interim standard, each revision to the requirements for flame resistance and corrosiveness GSA issues. GSA has recently issued a revision, HH-I-515D, containing requirements for flame resistance and corrosiveness that supersede the requirements of HH-I-515C. If this revision is incorporated into the interim rule, the revision may provide additional protection to the public without the need for the Commission to develop its own standard under section 7 of the act. Therefore, in accordance with section 7 of the CPSA the Commission withdraws the notice of proceeding to develop a standard to address the risk of injury from fires associated with cellulose (43 FR 10427, March 13, 1978).

EXTENSION OF TIME TO PROPOSE AN AMENDMENT TO THE INTERIM STANDARD

Pub. L. 95-319 requires the Commission to publish as a proposed amendment to the Commission's interim standard for cellulose insulation each revision issued by GSA that supersedes the requirements for flame resistance and corrosiveness in GSA specification HH-I-515C. The Commission must publish such a revision as a proposed amendment within 45 days after having received notice from the Administrator of the General Services Administration, or, if a revision becomes effective between February 1, 1978 and the effective date of the act, within 45 days of the effective date of the act. Pub. L. 95-319 provides that the Commission may extend the 45-day period for publishing the proposed amendment by 150 days if the Commission determines that an extension is necessary to study the technical and scientific basis for the revision, or to study the safety and economic consequences of the revision.

On June 15, 1978, GSA specification HH-I-515D became effective. This specification contains requirements for the flame resistance and corrosiveness of cellulose insulation that supersede the flame resistance and corrosiveness provisions of HH-I-515C. Therefore, the Commission must publish the proposed amendment to the interim standard by August 24, 1978, unless the Commission extends this period.

The Commission believes that it is necessary to extend the period of time for proposing the flame resistance and corrosiveness requirements of HH-I-515D as an amendment to the interim standard in order to study the technical and scientific basis and the safety and economic consequences of these requirements. Pub. L. 95-319 provides that the Commission may not issue an amendment to the interim standard if the Commission determines, after considering public comments, that the amendment is not necessary to protect consumers from the unreasonable risk of injury associated with flammable or corrosive cellulose insulation or if the Commission determines that implementation of the amendment will create an undue burden on persons subject to the interim standard. Therefore, the Commission is required to consider these issues.

The Commission expects that an extension of the time to propose an amendment to the interim standard will allow the Commission to fill gaps in the technical data, consolidate and update current economic data, and resolve data conflicts in both the technical and economic areas. Professional

technical judgment on the properties and performance of cellulose insulation continues to vary among industry experts. Additional technical knowledge may provide assistance in analyzing the economic consequences of the revision. Corrosion testing of cellulose insulation has been conducted by Underwriters Laboratories and Dynatech R/D Company in recent weeks. Preliminary indications are that a high percent of the material tested failed. Results of the corrosion test in the interim standard are not expected to vary to a significant degree from results of corrosion tests under the revision to the interim standard. As a result, empirical data on the corrosion

test in the interim standard, which will be generated when the interim standard becomes effective, on September 8, 1978, may assist in evaluating the economic consequences of the revision. The Commission believes that an extension of 150 days is necessary to study the technical and scientific basis and safety and economic consequences of the revision. If the Commission is able to complete its work before January 22, 1979, the Commission will publish the proposal at an earlier date. Therefore, in accordance with section 35(c)(2)(c)(ii) of the act, as amended by Pub. L. 95-319, the Commission extends by 150 days, from August 24, 1978 until January 22,

1979, the time in which it must publish the flame resistance and corrosiveness requirements of GSA specification HH-I-515D as a proposed amendment to the interim standard for cellulose insulation at 16 CFR part 1209. In accordance with Pub. L. 95-319, this period may be further extended by the Commission if that becomes necessary.

Dated: August 2, 1978.

SHELDON D. BUTTS,
Acting Secretary, Consumer Product Safety Commission.

[FR Doc. 78-22035 Filed 8-7-78; 8:45 am]

[6355-01]

Title 16—Commercial Practices

CHAPTER II—CONSUMER PRODUCT SAFETY COMMISSION

PART 1209—INTERIM SAFETY STANDARD FOR CELLULOSE INSULATION

Establishment of Interim Safety Standard

AGENCY: Consumer Product Safety Commission.

ACTION: Establishment of interim standard.

SUMMARY: In this document the Commission issues an interim mandatory safety standard to eliminate or reduce unreasonable risks of injury to consumers from flammable and corrosive cellulose insulation. In recently enacted legislation, Congress directed the Commission to issue this interim standard. The interim standard is based on flame resistance and corrosiveness provisions in a Federal specification for cellulose insulation issued by the General Services Administration (HH-I-515C). In addition, the interim standard requires manufacturers and private labelers of cellulose insulation to provide a specific informative label on all containers of cellulose insulation.

DATES: The interim standard is effective on September 8, 1978. Cellulose insulation manufactured after September 7, 1978, must comply with the interim standard.

FOR FURTHER INFORMATION CONTACT:

Wade D. Anderson, Directorate for Compliance and Enforcement, Consumer Product Safety Commission, Washington, D.C. 20207, 301-492-6400.

SUPPLEMENTARY INFORMATION:

I. BACKGROUND

LEGISLATION

On July 11, 1978, the "Emergency Interim Consumer Product Safety Standard Act of 1978," Pub. L. 95-319, became law. This legislation amended the Consumer Product Safety Act (CPSA) (15 U.S.C. 2051 et seq.) by adding a new section, section 35, that provides an interim consumer product safety standard for cellulose insulation. In establishing this interim standard, Congress found that:

(1) Existing Federal, State, and local laws and regulations are insufficient to protect the consumer from improperly manufactured cellulose insulation;

(2) An unreasonably large quantity of cellulose insulation is being distributed that does not meet minimum safety standards;

(3) An urgent need exists for the expedited setting of interim mandatory Federal standards for the manufacture of cellulose insulation; and

(4) Such standards are reasonably necessary to eliminate or reduce an unreasonable risk of injury to consumers from flammable or corrosive cellulose insulation.

The new section 35(a)(1) of the CPSA, provides that 60 days after July 11, 1978, the day the legislation became law, the requirements for flame resistance and corrosiveness in the General Services Administration's (GSA) specification for cellulose insulation, HH-I-515C (as that specification was in effect on February 1, 1978) are considered to be an interim consumer product safety standard having all the authority and effect of any other consumer product safety standard issued by the Commission under the Act.

Section 35(a)(2) of the Act requires the interim consumer product safety standard to provide that any cellulose insulation that is a consumer product must have a flame spread rating of 0 to 25, determined in accordance with the test procedures as provided by the GSA specification. The legislation provides that during the 45-day period after the effective date of the legislation, the Commission may make technical nonsubstantive changes in the GSA specification to make the requirements suitable for issuance as a consumer product safety standard. During this 45-day period the Commission must publish in the FEDERAL REGISTER any technical nonsubstantive changes it makes to GSA specification HH-I-515C.

In accordance with the legislation, by September 8, 1978, the Commission must publish in the FEDERAL REGISTER the interim consumer product safety standard, as altered. In this document the Commission is publishing the technical nonsubstantive changes it has made to he GSA requirements and is publishing the interim standard, as altered by these changes.

Section 35(b) of the Act provides that judicial review of the interim consumer product safety standard, is limited solely to the issue of whether any technical changes made by the Commission are nonsubstantive.

Section 35(c)(1)(A) of the Act provides that any interim consumer product safety standard established under that section is to be enforced in the same manner as any other consumer product safety standard. A violation of the interim standard is considered to be a violation of a consumer product safety standard issued by the Commission under section 9 of the Act. Thus, on and after the effective date of the interim standard, it shall be an unlawful act under section 19(a) of the CPSA (15 U.S.C. 2068(a)) for any person to manufacture for sale, offer for sale, distribute in commerce, or import into the United States any cellulose insulation subject to the interim standard which is not in conformity with this interim standard. The civil and criminal penalty provisions of sections 20 and 21 of the Act (15 U.S.C. 2069, 2070) are available to the Commission in enforcing this interim standard. In addition, the injunctive and seizure enforcement provisions of section 22 of the Act (15 U.S.C. 2071) are available to the Commission in enforcing the interim standard.

REVISIONS TO THE INTERIM STANDARD AND ESTABLISHMENT OF A FINAL STANDARD

The "Emergency Interim Consumer Product Safety Standard Act of 1978" provides, at section 35(c)(1)(B), that the Commission must issue a final safety standard for cellulose insulation if it determines that the interim consumer product safety standard does not adequately protect the public from the unreasonable risk of injury associated with flammable or corrosive cellulose insulation. A final standard must be issued under 5 U.S.C. 553, except that the Commission must give interested persons an opportunity for the oral presentation of data, views, or arguments in addition to an opportunity to make written submissions. A transcript must be kept of any oral presentation. The provisions of section 9 (b), (c), and (d) of the Act apply to the issuance of a final standard.

The "Emergency Interim Consumer Product Safety Standard Act of 1978" also provides that until a final consumer product safety standard is in effect, the Commission must incorporate into the interim standard each revision GSA issues that supersedes the requirements for flame resistance and corrosiveness in GSA specification HH-I-515C. The Commission must propose the revision and give interested persons an opportunity to comment on any proposed amendment. The Commission must issue the amendment unless the Commission determines, after consulting with the Secretary of Energy, that the amendment is not necessary to protect consumers from the unreasonable risk of injury associated with flammable or corrosive cellulose insulation or that implementation of the amendment will create an undue burden on persons who are subject to the interim consumer product safety standard.

The General Services Administration has informed the Commission that, effective June 15, 1978, it has issued GSA specification HH-I-515D. Since this specification contains requirements for flame resistance and

corrosiveness for cellulose insulation that supersede the requirements of GSA specification HH-I-515C, the Commission is required by Pub. L. 95-319 to publish the flame resistance and corrosiveness provisions of HH-I-515D as a proposed amendment to the interim standard issued here. Elsewhere in this issue of the FEDERAL REGISTER the Commission has extended, from August 24, 1978, until January 22, 1979, the time in which it must publish the proposed amendment to the interim standard.

COMMISSION ACTIVITIES CONCERNING CELLULOSE INSULATION

On October 20, 1976, the Commission received a petition (CP 77-1) from the Metropolitan Denver District Attorney's Consumer Office requesting the Commission to initiate a standard development proceeding to address certain risks of injury alleged to be associated with cellulose, fibrous glass, and plastic foam/resin home insulation.

After considering information gathered by its staff in analyzing the issues raised by the petition, the Commission, on August 22, 1977, held a public meeting to enable interested persons to present data, views, and arguments to assist the Commission in determining whether or not the petition should be granted. The Commission solicited written comments on the petition until October 21, 1977. After considering the oral and written comments, as well as an oral briefing of the issues by the staff, the Commission on November 10, 1977, instructed the staff to prepare a briefing package and a draft FEDERAL REGISTER notice to initiate a standard development proceeding to address the fire hazards associated with cellulose home insulation. On February 9, 1978, after considering this information, the Commission preliminarily determined that a consumer product safety standard is necessary to eliminate or reduce the unreasonable risk of injury from fire associated with cellulose home insulation.

On March 13, 1978, the Commission published a notice in the FEDERAL REGISTER (43 FR 10427) to begin a proceeding under section 7 of the CPSA (15 U.S.C. 2056) to develop a mandatory standard to address the unreasonable risk of injury from fire associated with cellulose home insulation. The notice invited interested persons to submit either (1) an offer to develop a recommended consumer product safety standard or (2) an existing standard to serve as a recommended consumer product safety standard. In response to the notice of proceeding, the Commission received 11 submissions from interested persons. As a result of the passage of the legislation and the Commission's issuance of an interim safety standard for cellulose insulation, the Commission, in a notice published elsewhere in this issue of the FEDERAL REGISTER, has withdrawn the notice of proceeding.

II. DESCRIPTION OF THE INTERIM STANDARD

The interim standard, 16 CFR Part 1209, published below, prescribes flame resistance and corrosion requirements for cellulose insulation manufactured for use as a consumer product. The interim standard applies to all such cellulose insulation manufactured after September 7, 1978.

Although the interim standard prescribes test methods to determine whether cellulose insulation meets the requirements of the interim standard, the interim standard itself does not require that a manufacturer test products. However, section 14 of the Consumer Product Safety Act (CPSA) (15 U.S.C. 2063) requires any manufacturer or private labeler of a product subject to a standard to certify that the product conforms to the standard. The certification must be based on either a test of each product or a reasonable testing program. The Commission may in the future issue regulations or provide guidelines as to what constitutes a reasonable testing program for certification purposes. However, for the present, manufacturers and private labelers must determine what constitutes a testing program adequate to insure that the product being produced and distributed conforms to the interim standard. For the present, for purposes of enforcement, the Commission intends to use the test procedures in the interim standard to determine whether items meet the requirements of the standard.

After September 7, 1978, no person shall manufacture for sale, offer for sale, distribute in commerce, or import into the United States cellulose insulation subject to the interim standard which does not comply with the interim standard. Cellulose insulation manufactured before September 8, 1978, is not subject to the interim standard and may be offered for sale, distributed in commerce, or imported into the United States after the effective date of the interim standard.

As provided by Pub. L. 95-319, the interim standard is intended to eliminate or reduce the unreasonable risk of injury to consumers presented by flammable and corrosive cellulose insulation. The interim standard contains the requirements for flame resist- ance and corrosiveness set forth in the GSA specifications for cellulose insulation HH-I-515C (as that specification was in effect on February 1, 1978). In addition, it contains requirements imposed by Pub. L. 95-319. In

particular, the interim standard is based on the following:

1. Paragraph 3.1 of the GSA specification, which specifies material requirements relating to flame resistance permanency and corrosion by referencing American Society for Testing and Materials (1916 Race Street, Philadelphia, Pa. 19103) (ASTM) C 739-77 "standard specification for cellulosic fiber (wood-base) loose fill thermal insulation" (ASTM C 739-77),

2. Subparagraph 3.2.1 of the GSA specification, which provides for a specified flame spread rating when tested in accordance with ASTM E 84-77a "standard test method for surface burning characteristics of building materials" (ASTM E 84-77a),

3. Provisions of ASTM C 519-65 "standard test method for density of fibrous loose fill building insulation" (ASTM C 519-65) providing alternate test methods for determining the density of insulation as specified by the manufacturer, or chosen by the Commission where the manufacturer does not specify the test method for determining density,

4. Provisions of ASTM D 2016-74 "standard test methods for moisture content of wood" (ASTM D 2016-74) providing a standard test method for determining the moisture content of wood. These provisions are referenced in the procedures for calibration of test equipment for determining flame spread classification that are included in ASTM C 739-77 and ASTM E 84-77a respectively,

5. The requirement in the act that cellulose insulation must have a flame spread rating of 0 to 25, when tested in accordance with the procedures in the interim standard, and

6. The requirement in the act for labeling of containers of cellulose insulation.

Following is a section-by-section description of the interim standard.

A. SCOPE AND APPLICATION (§ 1209.1)

Section 1209.1 of the interim standard describes its scope and application. As required by the act, the interim standard prescribes flame resistance and corrosion requirements for cellulose insulation. The interim standard applies to cellulose insulation that is a consumer product, i.e. insulation that is produced or distributed for sale to or for the personal use, consumption, or enjoyment of consumers in or around a permanent or temporary household or residence, a school, in recreation, or otherwise. The interim standard applies to cellulose insulation that is produced or distributed for sale to consumers for their direct installation or use, as well as insulation that is produced or distributed for installation by professionals. As required by section 9(d)(1) of the act (15 U.S.C.

2058(d)(1)) and the new section 35(a)(1), the interim standard applies only to cellulose insulation manufactured on or after the effective date of the interim standard (September 8, 1978).

B. DEFINITIONS (§ 1209.2)

Section 1209.2 of the interim standard defines the consumer product covered by the interim standard. For purposes of the interim standard, "cellulose insulation" means cellulosic fiber, loose fill, thermal insulation that is suitable for blowing or pouring applications. The definition includes insulation installed using the "wet process" method of installation. (The "wet process" insulation is blown into an area with a spray or mist of water applied at the nozzle during installation.)

C. GENERAL REQUIREMENTS (§ 1209.3)

Section 1209.3 of the interim standard lists the general requirements of the interim standard. Section 1209.3(a) requires all cellulose insulation covered by the interim standard to have a flame spread rating not greater than 25 when tested in accordance with the test procedures at § 1209.4. This provision is required by the new section 35(a)(2) of the act. Paragraph 1.2 of the GSA specification requires insulation to be of either of two classes—one with a flame spread rating of 0-25 and the other with a flame spread rating of 26-50, when tested in accordance with the test method provided in ASTM E 84-77a (the test method provided at section 1209.4 of the interim standard). The legislative history of Pub. L. 95-319 indicates that Congress intended the interim standard to narrow the range of acceptable cellulose insulation for a number of reasons. First, the GSA specification at paragraph 6.6 recommends that cellulose insulation with a flame spread rating not exceeding 25 be used in applications which require a higher flame spread resistance. The legislative history states that installation of cellulose insulation in homes presents such a situation. In addition, because the conditions where cellulose insulation is installed and installation techniques for insulation for consumer use cannot always be checked as they could in a GSA procurement situation, the legislative history concludes that caution requires the use of material with greater flame resistance. According to the legislative history, a flame spread rating of 0-25 should provide a greater measure of safety to consumers. (H.R. Rept. No. 95-1116 95th Cong., 2d sess., 5 (1978).)

Section 1209.3(b) of the interim standard requires all cellulose insulation covered by the interim standard to be treated with fire retardant chemicals that are permanent when tested in accordance with the flame resistance permanency test at § 1209.5 of the interim standard. This requirement is derived from paragraph 3.1 of the GSA specification HH-I-515C, which requires cellulose insulation to be in accordance with ASTM C 739-77. ASTM C 739-77 provides a test for flame resistance permanency, at paragraph 10.4, designed to determine the permanency of the chemicals used as fire retardants. The requirement that fire retardant chemicals be permanent has been included in the interim standard as a flame resistance requirement since this property directly affects the flame resistance of the cellulose insulation. Cellulose insulation that is manufactured with fire retardant chemicals that are not permanent in nature may not retain the flame resistant properties required by the interim standard.

Section 1209.3(c) of the interim standard requires that all cellulose insulation subject to the standard not be corrosive when tested in accordance with the test procedures for corrosiveness at § 1209.6. Section 35(a)(1) of the act requires the Commission to include in the interim standard the requirements for corrosiveness in GSA specification HH-I-515C. This requirement at § 1209.3(c) is derived from paragraph 3.1 of the GSA specification HH-I-515C, which requires cellulose insulation to be in accordance with ASTM C 739-77. ASTM C 739-77, at paragraph 10.7, provides a test to determine the corrosive properties resulting from high humidity and moisture and from chemical constituents of the insulation, which may react with metal sidings and other metallic building materials.

Section 1209.3(d) of the interim standard requires containers of cellulose insulation to have a labeling statement in accordance with the labeling requirements at section 1209.9. Section 35(a)(3) of the act requires each manufacturer or private labeler of cellulose insulation to include this statement on any container of cellulose insulation.

The Commission has not included in this interim standard the requirement at paragraph 3.2.2 of HH-I-515C that material have a smoke developed rating not greater than 50 when tested in accordance with ASTM E 84. Section 35(a)(1) of the act, as amended, requires the Commission to include the requirements for flame resistance and corrosiveness set of forth in HH-I-515C. The smoke developed rating requirement of HH-I-515C has not been included in the interim standard since it is not part of the requirements for flame resistance or corrosiveness set forth in HH-I-515C.

Paragraph 1.3 of ASTM E 84-77a states that there is not necessarily a relationship among measurements for smoke density and flame spread rate. The smoke developed rating measurement of subparagraph 3.2.2 of HH-I-515C does not necessarily establish a relationship between the density of smoke and its lethality. For example, although low levels of particulate matter may be detected from the combustion of some materials, giving a passing smoke development rating, the level of CO gas may be high. A frequently stated cause of death associated with fires is smoke inhalation of toxic gases, such as CO and CO_2. The Commission has also not included in the interim standard the provisions of ASTM E 84-77a for recording photoelectric cell measurements and determining smoke developed rating, since these provisions are not part of the flame resistance or corrosiveness provisions of HH-I-515C.

Although the interim standard does not include those provisions of GSA specification HH-I-515C that reference the procedure for determining smoke developed rating (ASTM E 84-77a, 3.8, 5.8, 5.9, 6.4, 6.7, 7.2) the Commission believes that the equipment used to measure smoke developed rating should be included in the description of the Steiner Tunnel test apparatus for determining flame resist- ance. Accordingly, at § 1209.4(a) (7) and (8) the Commission has included in the description of the Steiner Tunnel test apparatus the description of the equipment in ASTM E 84-77a used to obtain a measure of the smoke developed rating. This equipment is normally used in conjunction with the Steiner Tunnel test apparatus. Although the equipment is not used in testing under this standard, the description of the apparatus includes this equipment since removal of the equipment could conceivably cause variability of test results.

The Commission has not included subparagraph 1.1 of HH-I-515C, Scope, as part of the interim standard since this subparagraph refers to the scope of the GSA specification and is inappropriate for inclusion as part of a mandatory standard. However, at § 1209.1 of the interim standard the Commission has included a section that describes the scope and application of the interim standard, as provided by Pub. L. 95-319.

The Commission has not included paragraph 2 of HH-I-515C, applicable documents, as part of the interim standard since the interim standard includes the applicable text of ASTM C 739-77 and ASTM E 84-77a and the documents in paragraph 2 of HH-I-515C that are included in the flame resistance and corrosiveness requirements of HH-I-515C.

The Commission has also not included in the interim standard the requirement at paragraph 3.1.4 of HH-I-515C

that the density of loose fill insulation must be not more than 3 pounds per cubic foot when tested as specified in ASTM C-739. This requirement has not been included in the interim standard since it is not part of the requirements for flame resistance or corrosiveness set forth in HH-I-515C.

The Commission has not included in the interim standard subparagraphs 3.1.2 reclaimed fibers, 3.1.3 reclaimed fiber content, 3.1.5 starch, and 3.2.3 workmanship, of HH-I-515C since these subparagraphs are not part of the flame resistance or corrosiveness requirements of HH-I-515C.

The Commission has not included in the interim standard paragraphs 3.2 marking, 4 quality assurance provisions, 5 preparation for delivery, and 6 notes, of HH-I-515C since these paragraphs are not part of the flame resistance or corrosiveness requirements of HH-I-515C.

D. TECHNICAL, NONSUBSTANTIVE CHANGES IN THE FLAME RESISTANCE AND CORROSION REQUIREMENTS OF GSA SPECIFICATION HH-I-515C.

The new section 35(a)(1) of the CPSA authorizes the Commission to make technical, nonsubstantive changes in the flame resistance and corrosion requirements of GSA specification HH-I-515C to make these requirements suitable for issuance as a consumer product safety standard. Section 35(b) provides that judicial review of the interim standard is limited solely to the issue of whether any technical changes the Commission has made are nonsubstantive. Section 35(b) of the act also provides that for purposes of judicial review, any change made by the Commission which requires any test to determine the flame spread rating of cellulose insulation to include a correction for variations in test results caused by equipment used in the test shall be considered a technical, nonsubstantive change.

The legislative history of the act describes technical nonsubstantive changes as "changes which will not create a significant impact on the regulated industry." (H.R. Rep. No. 95-1322, 95th Cong., 2d sess. 9 (1978) and H.R. Rep. No. 95-1116, 95th Cong., 2d sess. 5 (1978).)

In attempting to apply the legislative criteria to the changes it has made to the GSA specification the Commission believes it is helpful to examine cases where the courts have considered similar criteria for assessing the impact of administrative actions on regulated industry. In interpreting the notice and comment requirements under the Administrative Procedure Act (5 U.S.C. 553) the court in *Pharmaceutical Manufacturer's Association* v. *Finch*, 307 F. Supp. 858

(1970), held that certain regulations were invalidly issued without an opportunity for notice and comment since the regulations would have had a substantial impact on persons affected by the regulations. The court found that the regulations were pervasive in their scope and had an immediate and substantial impact on the way industry members conducted their everyday business. The regulations applied to more than 2,000 drug products first marketed between 1938 and 1962 with FDA approval and placed all of the products in jeopardy, subject to summary removal by order of the FDA. In *Texaco, Inc.* v. *Federal Power Commission*, 412 F. 2d 740 (3d Cir. 1969), the court held that an administrative rule was invalidly issued without an opportunity for notice and comment since the rule was not "minor". The rule in question would have established for the first time the requirement that compound interest be paid on amounts ordered refunded and would affect many natural gas companies and potentially involve large sums of money. If the considerations in these cases for assessing the impact of administrative action on persons subject to the action are applied to the changes the Commission has made to HH-I-515C, the changes made by the Commission do not have a significant impact on the regulated industry. Manufacturers who are currently complying with the flame resistance and corrosiveness requirements of HH-I-515C would not be subject to a substantial impact on their everyday business and would not be subject to new requirements having a potentially severe impact on their business. The Commission has carefully considered each of the changes it has made to HH-I-515C and has determined that the changes, considered separately and collectively, are technical, nonsubstantive changes that will not create a significant impact on the regulated industry.

In issuing the interim standard, the Commission has made various technical, nonsubstantive changes and editorial changes in the flame resistance and corrosion requirements of the GSA specification. The Commission does not believe that these changes will have a significant impact on the regulated industry. The Commission made these changes in order to:

(1) Ease some of the restrictive specifications for the test apparatus and test procedures,

(2) Simplify the test procedures,

(3) Eliminate provisions in the requirements that are unrelated to cellulose insulation, and

(4) Increase the likelihood that consistent test results will be obtained.

The Commission staff has discussed the technical changes with many persons who operate and are familiar

with the test equipment requirements included in the interim standard. None of these persons indicated that the changes would have any impact on the regulated industry, let alone a significant impact.

The Commission has also made several editorial changes in the flame resistance and corrosion requirements of GSA Specification HH-I-515C. These changes are nonsubstantive and are intended to clarify the meaning and application of the requirements and also make the requirements suitable for issuance as a consumer product safety standard. They involve, primarily, changes needed to join together various provisions of the GSA specification that apply to corrosiveness- and flame-resistance requirements.

The Commission has made the following technical nonsubstantive changes:

(1) The Commission has added tolerances to a number of measurements in §§ 1209.4 and 1209.7. The purpose of these tolerances is to allow a limited leeway for variations in test procedures or equipment. The tolerances in describing the test apparatus are included since it is not practical to manufacture commercially a product to zero tolerance. The changes that are included accurately describe existing test apparatus. The changes will not have a significant impact on regulated persons since they will ease restrictive specifications of the test apparatus that could limit the availability of the test apparatus. The tolerances that have been included in describing the distances or durations for recording measurements have been included since it is not practical to record a distance or time duration to a zero tolerance. These changes will not have a significant impact on regulated persons since they will ease some of the restrictive specifications for the test procedures.

The Commission has made the following specific changes related to tolerances:

At § 1209.4(a)(1) of the interim standard, the Commission has included a tolerance of $\pm\frac{1}{16}$ inch to describe the thickness of the asbestos fabric gasketing tape, as well as a tolerance of ± 3 inches to describe the length of the fire test chamber. At § 1209.4(a)(4) the Commission has replaced nominal 2 inches with a tolerance of 3 ± 1 inch to describe the insulation for the top of the fire chamber. At § 1209.4(a)(5) the Commission has included a tolerance of ± 1 inch to describe the spacing of the burners. At § 1209.4(a)(5) the Commission has added the word "nominal" to describe the pipe elbow burner outlet. This is to indicate that the number is being used as a name or label and may vary with industry custom or practice. At § 1209.4(a)(6)

the Commission has included a tolerance of ±¼ inch to describe the diameter of the flue pipe at the vent end of the fire test chamber. The Commission has also included a tolerance of minus 0, plus ¹⁄₁₆ inch to describe the embedded thermocouple. The Commission has, at § 1209.4(c)(1) included a tolerance of ±½₂ inch to describe the asbestos-cement board. At § 1209.4(c)(3) the Commission has included tolerances of ±1 inch (7 mm) to describe the distance for recording the air velocity from the burner ports and to describe the length of the straightening vanes. At § 1209.4(c)(5) the Commission has included a tolerance of ±6 inches to describe the distance the test flame must extend downstream. At § 1209.4(c)(8) the Commission has included a tolerance of ±6 inches to describe the distance intervals for making observations in calibration tests with red oak flooring that are conducted in the fire test chamber. At § 1209.4(d)(1) the Commission has included tolerances of ±¼ inch and ±¹⁄₁₆ inch to describe the test frame supporting the specimen holder. In this same section, the Commission has described the steel angles of the test frame with nominal dimensions, to indicate that the dimensions may vary with industry custom or practice. At § 1209.4(d)(3) the Commission has included a tolerance of ±2 seconds to describe the duration of the test for determining flame front distance.

(2) At § 1209.4(a)(5) the Commission has included a provision in the description of the fire test chamber that would, as an option of the test operator, allow a draft gage tap to be inserted through the top of the fire end of the tunnel. This change will not have a significant impact on persons subject to the interim standard since it is an option. This location for the draft gage tap to indicate static pressure is currently under consideration by the ASTM Steiner Tunnel operators and is intended to make the test more reproducible. At § 1209.4(c)(3) the Commission has included an alternate air velocity reading range to be used if the draft gage tap is inserted through the top of the "fire end" of a tunnel.

(3) At § 1209.4(a) (7) and (8) the Commission has included in the description of the Steiner Tunnel test apparatus for measuring flame resistance the description of the equipment in ASTM E 84-77a used to obtain a measure of the smoke developed rating. The smoke developed rating measurement is not required under the interim standard, since it is not a part of the flame resistance or corrosiveness requirements of GSA specification HH-I-515C. Accordingly, the interim standard does not include those provisions of the GSA specification HH-I-515C that reference the proce-

dure for determining smoke developed rating (ASTM E 84-77a, 3.8, 5.8, 5.9, 6.4, 6.7, 7.2). However, the Commission believes that the equipment used to measure smoke developed rating should be included in the description of the Steiner Tunnel test apparatus because the smoke developed rating equipment is normally used in conjunction with the Steiner Tunnel test apparatus, and the removal of the equipment could result in variability of the test results.

(4) At § 1209.4(c)(3) the Commission has corrected a typographical error in the ASTM standard. The metric measurement of the air velocity should be expressed as "73.2" instead of "7.32" meters. At § 1209.4(c)(8) the Commission has corrected another typographical error in the ASTM standard. The measurement of the red oak flooring should be 25/32 inch instead of the 23/32 inch.

(5) At § 1209.4(d)(1) the Commission has changed the description of the screen for holding the test specimen from "galvanized steel" to "steel." Operators of the tunnel test apparatus have indicated to the Commission that galvanized steel screens may be difficult to obtain at this time and that many of the tunnel operators are presently using other forms of steel screening. Since the tunnel operators have indicated that the type of steel material used in the screening does not have an effect on the test results, this change would not have a significant impact on persons subject to the interim standard. At § 1209.4(d)(1) of the interim standard, the Commission has included a description of the wire size for the metal screen in order to minimize variations in test results. The tunnel operators have indicated to the Commission that these wire sizes, with the tolerances indicated, are currently being used, so that persons subject to the interim standard would not be affected by the inclusion of this specification.

(6) At § 1209.4(d)(1) the Commission has included a provision that would allow the Commission to determine the density of the cellulose insulation using the blown in and/or poured density test method at § 1209.7, if the manufacturer fails to specify the density of the insulation. The inclusion of this provision will not have a significant impact on persons subject to the standard since this section preserves the option of the manufacturer to specify the density of the insulation. HH-I-515C, through appendix X1.6 of ASTM E 84-77a, provides that in preparing specimens for the flame spread classification test, the insulation shall be packed to the density specified by the manufacturer. By including a provision that would allow the Commission to determine the density, the

Commission has avoided the situation where the flame spread classification test could not be conducted because of the failure of a manufacturer to specify the density of the insulation. The test method at § 1209.7 is derived from ASTM C 519-65, "The Standard Test Method for Density of Fibrous Loose Fill Building Insulation." This test method is commonly used for determining the density of cellulose insulation, and has been referenced in paragraph 3.1.4. of HH-I-515C.

(7) At § 1209.4(f) of the interim standard, the Commission has not included paragraph 8.1 of ASTM E 84-77a, Analysis of Products of Combustion. This paragraph provides that during the progress of the test for determining surface burning characteristics, products of combustion may be drawn from the test duct for chemical analysis. Since this provision is not required as part of the test method and is an optional provision, the Commission does not believe that this provision is apropriate for inclusion in the mandatory standard.

(8) At § 1209.4(f)(4) of the interim standard, the Commission has deleted "delamination" and "shrinkage" as burning characteristics to be observed in the flame spread classification test. Delamination and shrinkage are characteristics that are unrelated to cellulose insulation.

(9) At § 1209.6(a)(4) of the interim standard, the Commission has added 1,1,1-trichloroethane as an analytical reagent that may be used as a substitute for trichloroethylene in the test for corrosiveness. This addition has been made since trichloroethylene may present a carcinogenic hazard and 1,1,1-trichloroethane is a suitable degreasing substitute that has been tested and not found to be a carcinogen. The Commission has learned that at least one major corrosion testing organization is currently using 1,1,1-trichloroethane as an analytical reagent in this test. Although the use of 1,1,1-trichloroethane as a substitute reagent is not required, the Commission strongly recommends that persons conducting the test use 1,1,1-trichloroethane. Since 1,1,1-trichloroethane is a suitable substitute that is currently being used, the change will not have a significant impact on persons subject to the interim standard.

(10) At 1209.7 the Commission has not included an insulation thickness indicator which is included in ASTM C 519-65, Standard Test Method for Density of Fibrous Loose Fill Building Insulation. This indicator has not been included since the Commission does not consider it to be necessary for determining the insulation density. This change will have no effect on persons subject to the standard because the manufacturer has the option of speci-

fying the density at which his insulation should be tested for flame spread and because the density of the insulation can be accurately determined without this device.

E. TEST PROCEDURES (§ 1209.4, § 1209.5, § 1209.6, § 1209.7, § 1209.8)

(1) *Test procedures for flame resistance* (§ 1209.4, § 1209.7, § 1209.8). The interim standard at section 1209.4 includes test procedures for flame resistance. The test procedures at § 1209.4 are those of ASTM E 84-77a, the current version of the standard referenced at subparagraph 3.2.1. of GSA specification HH-I-515C. The test method involves the use of Steiner Tunnel test apparatus to determine how quickly the insulation will burn when compared to other materials. The insulation is assigned a "flame spread classification" based on an evaluation of the rate of flame spread over the surface of the test material when exposed to a test fire. For purposes of establishing a comparison, asbestos-cement board is assigned a flame spread classification of 0 when tested in the tunnel and red oak flooring is assigned a flame spread classification of 100. Section 1209.4(a) describes the design and construction of the fire test chamber. Section 1209.4(b) describes the test specimens and their conditioning.

At § 1209.4(c) the interim standard provides for the calibration of test equipment for conducting the flame spread classification tests. In conducting tests with red oak flooring to properly calibrate the Steiner Tunnel, the interim standard provides at § 1209.4(c)(8) that the red oak flooring must be conditioned to 6- to 8-percent moisture content as determined by the 221° F (105° C) oven-dry method described at § 1209.8. This test method is the oven-dry method in ASTM D 2016-74, "Standard Test Methods for Moisture Content of Wood," as provided in paragraph 5.8 of ASTM E 84-77a. At § 1209.4(c)(9) the interim standard provides that prior to performing the surface burning test for cellulose insulation, the operator must develop a correction factor for the red oak flooring incorporating the steel screening, as described in § 1209.4(b)(2). This correction factor, provided by subparagraph 10.3.1 of ASTM C 739-77, is intended to promote consistency in test results by requiring all test facilities which conduct the surface burning test in accordance with this standard to apply the appropriate correction factor. The metal screen absorbs heat and thus retards flame spread and may make a measurable difference in the determination of the flame spread rating of cellulose insulation. The purpose of the correction factor is to promote

uniformity among test results at different test facilities and to insure a flame spread rating that is indicative of the relative performance of the material in the Steiner Tunnel. The test material fails the interim standard if the corrected flame spread classification is over 25.

Since the method for determining flame spread rating under HH-I-515C requires that insulation be tested at a density specified by the manufacturer (appendix X1.6 of ASTM E 84-77a) the Commission has included this provision at § 1209.4(d)(1) of the interim standard. Although § 1209.4(d)(1) preserves the option of the manufacturer under HH-I-515C to specify the density at which the insulation should be tested, this section also provides that if the manufacturer fails to specify a density the Commission will determine the density of the insulation by using the blown in and/or poured density method at § 1209.7.

(2) *Test procedures for flame resistance permanency* (§ 1209.5). The interim standard, at section 1209.5 includes test procedures for determining flame resistance permanency. These test procedures are derived from paragraph 10.4 of ASTM C 739-77 and are required by paragraph 3.1 of GSA specification HH-I-515C. The test procedures subject the insulation to an accelerated aging procedure designed to determine the permanency of the chemicals used as fire retardants by aging a test specimen in a humidity chamber and then testing the aged and nonaged specimen in a 2-foot flame tunnel apparatus. If the insulation tested received a flame spread rating of greater than 20 when tested in the 25-foot Steiner Tunnel then the aged and unaged specimens must be tested directly in the 25-foot tunnel. A numerical determination is made of flame spread of the aged specimen and the nonaged specimen. Where flame spread of the aged specimen in the 2-foot apparatus is 1.20 or more times that of the nonaged specimen, the flame resistance permanency test must be repeated using the 25-foot Steiner Tunnel Test method specified for determining flame spread classification at § 1209.4. A change in flame spread classification in the 25-foot tunnel as modified in this standard constitutes a failure of the test.

(3) *Test procedures for corrosion* (§ 1209.6). The interim standard, at § 1209.6, includes test procedures for corrosion. These test procedures are the test procedures of paragraph 10.7 of ASTM C 739-77 and are required by § 3.1 of GSA specification HH-I-515C. The test is intended to determine the corrosive properties resulting from high humidity or moisture in cellulose insulation. From this action, varying amounts of chemical constituents may

migrate resulting in a possible reaction with metallic building materials. The test is an accelerated test intended to simulate conditions likely to cause chemical migration to metallic surfaces. The test involves comparison of corrosion between very thin aluminum, copper, and steel specimens in good contact with water-saturated insulation and duplicate metal control specimens not in contact with the test insulation. Both sets of metal specimens are placed in a humidity chamber for 7 days. Extended 30-day tests are conducted on aluminum and copper coupons when minor surface etching occurs. Extended 30-day tests are conducted on any steel coupon where corrosion of the insulated specimen compares unfavorably with that of its corresponding control specimen. Noncorrosiveness is determined by the absence of any perforations when the metal specimen is observed over a chrome reflected 40-watt appliance light bulb after the extended 30-day test. If any perforation occurs, then the sample has failed the test.

(4) *Reference to brand names.* At several sections the interim standard includes references to particular brands of products that have been found suitable by others for the purposes indicated in the interim standard. (See § 1209.4(a)(1), references to A. P. Green brick, Vycor and Pyrex glass; § 1209.4(a)(2), reference to Zircon; § 1209.4(a)(7) reference to Weston Instruments No. 856BB Photronic cell; § 1209.4(c)(3) reference to Thermo Systems, Inc., Model 1610 velocity transducer; and § 1209.5(a)(2) reference to Custom Scientific Instrument (CSI) 2-foot flame spread test tunnel (Model C-196CL).) These products are referenced in the portions of the ASTM standards that are included in the flammability and corrosion provisions of GSA specification HH-I-515C. Although the Commission staff has not verified that these products are in fact suitable or available for the specified purposes, the products are included in the interim standard as guidance for those persons conducting tests. Equivalent products may, of course, be used for the purposes specified in the interim standard.

III. OTHER CONSIDERATIONS

FINDINGS

Since the "Emergency Interim Consumer Product Safety Standard Act of 1978" establishes the interim consumer product safety standard by legislation, the Commission has not included in this interim standard the findings such as those regarding risk of injury and economic data under section 9(c) of the act (15 U.S.C. 2059(c)) that the Commission must consider before it can issue its own consumer product safety rule. In addition, for the same

reason the Commission has not included information usually required under section 9(b) of the act (15 U.S.C. 2058(b)) regarding special needs of elderly and handicapped persons to determine the extent to which such persons may be adversely affected by the rule. However, the Commission has no information suggesting that the interim standard would have any adverse effect on elderly and handicapped persons.

The National Environmental Policy Act requires all Federal agencies to prepare environmental impact statements on major Federal actions significantly affecting the quality of the environment. Since publication of this interim standard without substantive change is required by the legislation and is not committed to agency discretion, the Commission concludes that publication of the interim standard is not subject to the requirement of NEPA that an assessment of the environmental effects be made.

LABELING

Section 1209.9 of the interim standard contains the requirement of section 35(a)(3) of the act, that each manufacturer or private labeler of cellulose insulation include the following statement on any container of cellulose insulation manufactured after September 7, 1978: "Attention: This material meets the applicable minimum Federal flammability standard. This standard is based upon laboratory tests only, which do not represent actual conditions which may occur in the home."

The statement must appear prominently and conspicuously on the cellulose insulation container and must appear in conspicuous and legible type in contrast by typography, layout, and color with other printed matter on the container. CPSC regulations at 16 CFR 1500.121 provide type size, placement, and other requirements for cautionary labeling under the Federal Hazardous Substances Act (FHSA) (15 U.S.C. 1261). The Commission suggests that the FHSA regulations at 16 CFR 1500.121 be used as guidelines as to whether labeling required in this interim standard is prominent, conspicuous, and legible. (See also the legislative history of the act H.R. Rep. No. 95-1322, 95th Cong., 2d sess. 9 (1978).) Manufacturers or private labelers who need additional guidance or advice concerning their labels should contact the Commission's Directorate for Compliance and Enforcement, Division of Regulatory Management, 301-492-6400.

Manufacturers or private labelers may use a pressure-sensitive or glued-on label to meet this requirement provided the label is made and attached in such a manner that it will be legible

for the anticipated amount of time between the manufacture of the product and its installation.

LABELING REGARDING INSTALLATION

Although the interim standard does not include labeling or instructions for the proper installation of cellulose insulation, the Commission staff is preparing a proposed rule under section 27(e) of the CPSA that would require manufacturers of cellulose insulation to provide purchasers with performance and technical data relating to the proper installation of cellulose insulation.

In the notice starting its standard development proceeding for cellulose insulation, the Commission recognized the importance of properly installing cellulose insulation (42 FR 10428, March 13, 1978). Laboratory tests have shown the possibility of fires related to smoldering ignition of the insulation installed over recessed light fixtures. In addition, reported incidents and the technical analysis of the CPSC staff indicated to the Commission that cellulose insulation can be ignited if the insulation comes into contact with electrical devices or heat sources such as recessed lighting fixtures, trouble lights, and furnace flues and chimneys. The Commission also recognized that the future demand for cellulose insulation may lead to the increasing frequency of improper installation of the insulation, by professionals or consumers, so that increasing amounts of insulation may be exposed to ignition from a recessed lighting fixture or other ignition source in the installation area.

In the conference report on Pub. L. 95-319, the conference committee stated their expectation that the Commission would issue a rule under section 27(e) that would require manufacturers to provide safety information on installation, to consumers. (H.R. Rept. No. 95-1322, 95th Cong., 2d sess. 9-10 (1978).)

PREEMPTION

Section 26(a) of the CPSA provides that whenever a consumer product safety standard under the Act is in effect and applies to a risk of injury associated with a consumer product, no State or local government has the authority either to establish or to continue in effect any provision of a safety standard or regulation which prescribes any requirements as to the performance, composition, content, design, finish, construction, packaging, or labeling of such product which are designed to deal with the same risk of injury associated with such consumer product, unless such requirements are identical to the requirements of the Federal standard.

The Commission believes that the interim standard preempts all State and local requirements addressing the flame resistance and corrosion hazards associated with cellulose insulation. However, since the interim standard does not include any requirements addressing the installation of cellulose insulation, the Commission does not believe that the interim standard preempts any State or local government from establishing or continuing in effect requirements addressing the proper installation of cellulose insulation. In the conference report, the conference committee stated that the interim standard would not preempt State or local installation standards for cellulose insulation (H.R. Rept. No. 95-1322, 95th Cong., 2d sess. 10 (1978)).

CERTIFICATION

Manufacturers of cellulose insulation will be required to comply with the certification provisions of section 14(a)(1) of the Act (15 U.S.C. 2063(a)(1)) on and after the effective date of the interim standard. Section 14(a)(1) requires manufacturers (and private labelers, if the product bears a label) to issue a certificate which states that the product conforms to all applicable consumer product safety standards and specifies any applicable standard. The certificate shall be based on a test of each product or upon a reasonable testing program and must state the name of the manufacturer or private labeler issuing the certificate and include the date and place of manufacture. Section 14(b) provides that, at the option of the person required to certify the product, testing may be conducted by an independent third party qualified to perform such tests or testing programs. Section 35(f)(1) of the Act authorizes the Commission to require that any person required to comply with the certification requirements of section 14 for cellulose insulation must provide for the performance of any test or testing program through the use of an independent third party qualified to perform such test or testing program.

In addition, sections 14 (b) and (c) of the Act allow, but do not require, the Commission to issue regulations which would (1) prescribe a reasonable testing program, (2) specify which manufacturer shall issue the certificate when a product has more than one "manufacturer," and (3) require labeling of products subject to the safety standard. Manufacturers of products subject to a consumer product safety standard are required to issue a certificate under section 14(a)(1) based on a test of each product or on a reasonable testing program even if the Commission has not issued a regulation under section 14 (b) and (c). Although specif-

Ic certification and labeling requirments of the type authorized by section 14 (b) and (c) of the Consumer Product Safety Act are not included in the interim standard, such requirements may be developed in the future. Any rule on certification and labeling will be separately proposed for public comment in accordance with the requirements of the Administrative Procedure Act (5 U.S.C. 553).

STOCKPILING

Section 9(d)(2) of the Act (15 U.S.C. 2058(d)(2)) authorizes the Commission to issue a rule prohibiting manufacturers of consumer products from stockpiling these products in order to circumvent a consumer product safety standard. "Stockpiling" means manufacturing or importing a product between the date of issuance of a consumer product safety standard and its effective date at a rate which is significantly greater than the rate at which the product was produced or imported during a base period before the standard is issued. The legislative history of Pub. L. 95-319 indicates that the Commission has the authority to issue an antistockpiling rule for cellulose insulation subject to the interim standard (H.R. Rep. No. 95-1322, 95th Cong., 2d sess. 10 (1978)). The Commission has not included an antistockpiling rule in this interim standard since it does not believe that such a rule is necessary because of the short time between the issuance of the interim standard and its effective date. However, if the Commission determines that such a rule is necessary, the Commission may issue a rule at some later time before the interim standard becomes effective.

IV. EFFECTIVE DATE

As provided by section 35(a) of the Act, as amended by Pub. L. 95-319, the interim standard is effective on and after the last day of the 60-day period beginning on the effective date of section 35 of the Act. Since section 35(a) was effective July 11, 1978, the interim standard is effective on September 8, 1978. Cellulose insulation subject to this interim standard that is manufactured after September 7, 1978, must meet the requirements of the interim standard.

CONCLUSION

In accordance with the provisions of the "Emergency Interim Consumer Product Safety Standard Act of 1978," Pub. L. 95-319, the Commission issues the interim standard for cellulose insulation as set forth below.

Therefore, pursuant to provisions of the Consumer Product Safety Act as amended (sec. 35(a), Pub. L. 95-319, 92 Stat. 386, 15 U.S.C. 2082) a new part

1209 is added to title 16, chapter II, subchapter B, as follows:

Sec.
1209.1 Scope and application.
1209.2 Definitions.
1209.3 General requirements.
1209.4 Test equipment and procedures for flame resistance.
1209.5 Test procedures for flame resistance permanency.
1209.6 Test procedures for corrosiveness.
1209.7 Test procedures for density.
1209.8 Test procedures for determining the moisture content of wood.
1209.9 Labeling requirements.
1209.10 Certification and enforcement.
1209.11 Effective date.

AUTHORITY: Sec. 35(a), Pub. L. 95-319, 92 Stat. 386; (15 U.S.C. 2082).

§ 1209.1 Scope and application.

(a) *Scope.* This part 1209, an interim consumer product safety standard, prescribes flame resistance and corrosion requirements for cellulose insulation that is a consumer product. These requirements are intended to reduce or eliminate an unreasonable risk of injury to consumers from flammable and corrosive cellulose insulation. the requirements are the flame resistance and corrosiveness requirements of General Services Administration specifications HH-I-515C and include provisions of the following standards published by the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pa. 19103: ASTM C 739-77, "Standard Specification for Cellulosic Fiber (Wood-Base) Loose Fill Thermal Insulation"; ASTM E 84-77a, "Standard Test Method for Surface Burning Characteristics of Building Materials"; ASTM C 519-65, "Standard Test Method for Density of Fibrous Loose Fill Building Insulation"; and ASTM D 2016-74, "Standard Test Method for Moisture Content of Wood."

(b) *Application.* This part 1209 shall apply to cellulose insulation that is a consumer product. That is, cellulose insulation produced or distributed for sale to or for the personal use, consumption, or enjoyment of consumers in or around a permanent or temporary household or residence, a school, in recreation, or otherwise. The interim standard applies to cellulose insulation that is produced or distributed for sale to consumers for their direct installation or use, as well as cellulose insulation that is produced or distributed for installation by professionals. This part 1209 applies only to cellulose insulation manufactured after September 7, 1978.

§ 1209.2 Definitions.

As used in this part 1209:

(a) "Cellulose insulation" means cellulosic fiber, loose fill, thermal insulation that is suitable for blowing or pouring applications. The definition

includes insulation installed using the "wet process" method of installation. The "wet process" insulation is blown into an area with a spray or mist of water applied at the nozzle during installation.

(b) Definitions given in section 3 of the Consumer Product Safety Act are applicable to this part 1209.

§ 1209.3 General requirements.

(a) All cellulose insulation to which this interim standard applies, as described in § 1209.1, shall have a flame spread rating not greater than 25 when tested in accordance with the test procedures described at § 1209.4.

(b) All cellulose insulation to which this interim standard applies, as described in § 1209.1, shall pass the flame resistance permanency test at § 1209.5.

(c) All cellulose insulation to which this interim standard applies, as described in § 1209.1, shall be noncorrosive when tested in accordance with the test procedures at § 1209.6.

(d) All containers of cellulose insulation to which this interim standard applies, as described in § 1209.1, shall have a labeling statement in accordance with the labeling requirements at § 1209.9.

§ 1209.4 Test equipment and procedures for flame resistance.

(a) *Fire test chamber.*—(1) *Duct of chamber.* The fire test chamber, figs. 1 and 2, shall consist of a horizontal duct having an inside width of 17¾±¼ in. (451±6.3 mm) measured at the ledge location along the sidewalls and 17⅝±⅜ in. (448±10 mm) at all other points; a depth of 12±½ in. (305±13 mm) measured from the bottom of the test chamber to the ledge of the inner walls on which the specimen is supported (including the ⅛±¹⁄₁₆ in. (3.2 mm ±1.59 mm) thickness of asbestos fabric gasketing tape); and a length of 25 ft ±3 in. (7.62 mm ±76.2 mm). The sides and base of the duct shall be lined with an insulating masonry material as illustrated in fig. 2, consisting of A. P. Green, G-26 refractory firebrick or equivalent. (This method is based on the use of G-26 firebrick manufactured by A. P. Green Refractories, Green Boulevard, Mexico, Mo. 65265.) One side of the chamber shall be provided with double observation heat-resistant windows with the inside pane flush mounted (see fig. 2). (Heat-resistant glass, Vycor, 100 percent silica glass, nominal ¼ in. thick, has been found suitable for the interior pane; Pyrex glass, nominal ¼ in. thick, has been found suitable for the exterior pane.) Exposed inside glass shall be 2¾±⅜ in. by 11 plus 1, minus 2 in. (70±10 mm by 279, plus 25, minus 50 mm). The centerline of the exposed area of the inside glass shall be in the upper half of the furnace wall, with the upper edge not less than 2.5 in. (63

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mm) below the furnace ledge. The window shall be located such that not less than 12 in. (305 mm) of the specimen width can be observed. Multiple windows shall be located along the tunnel so that the entire length of the test sample may be observed from outside the fire chamber. The windows shall be pressure tight as described by § 1209.4(c)(2).
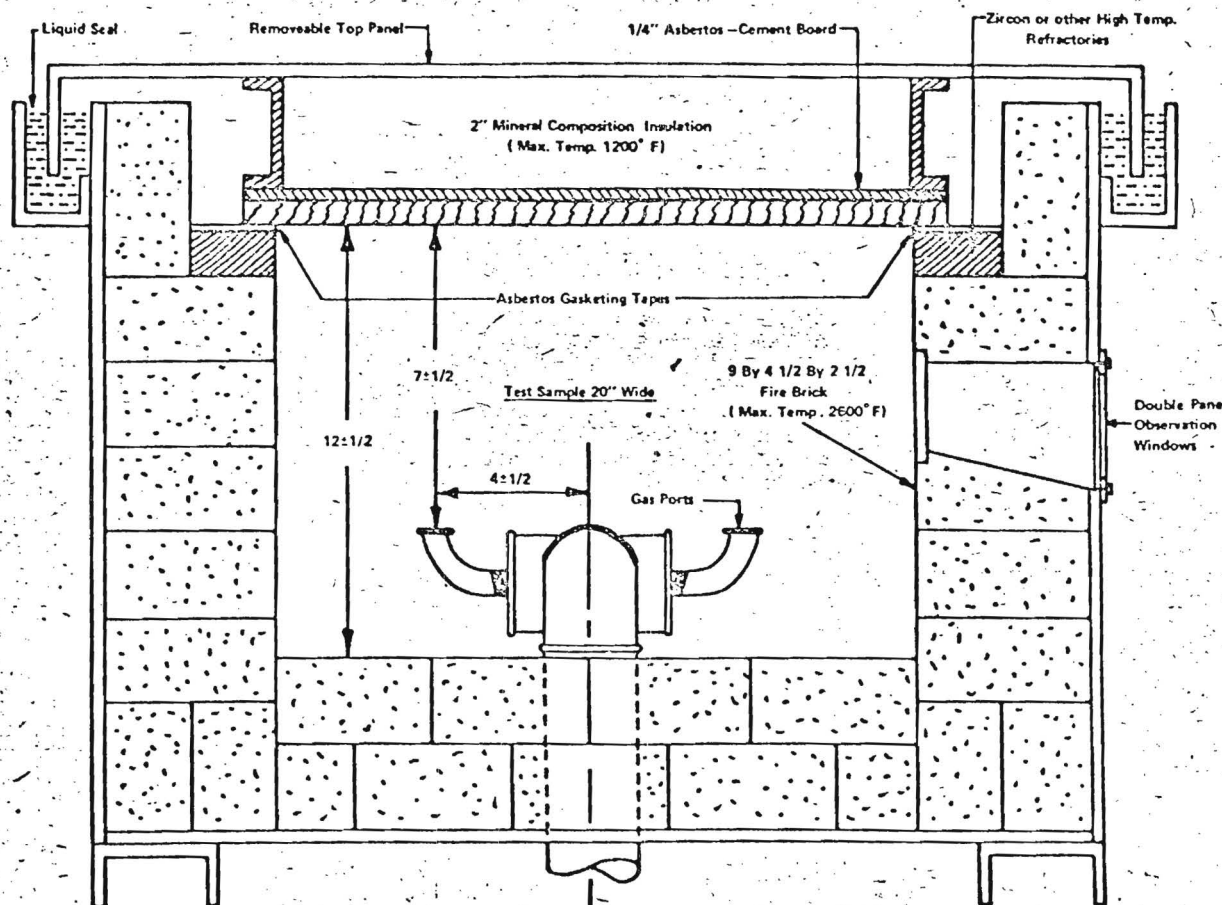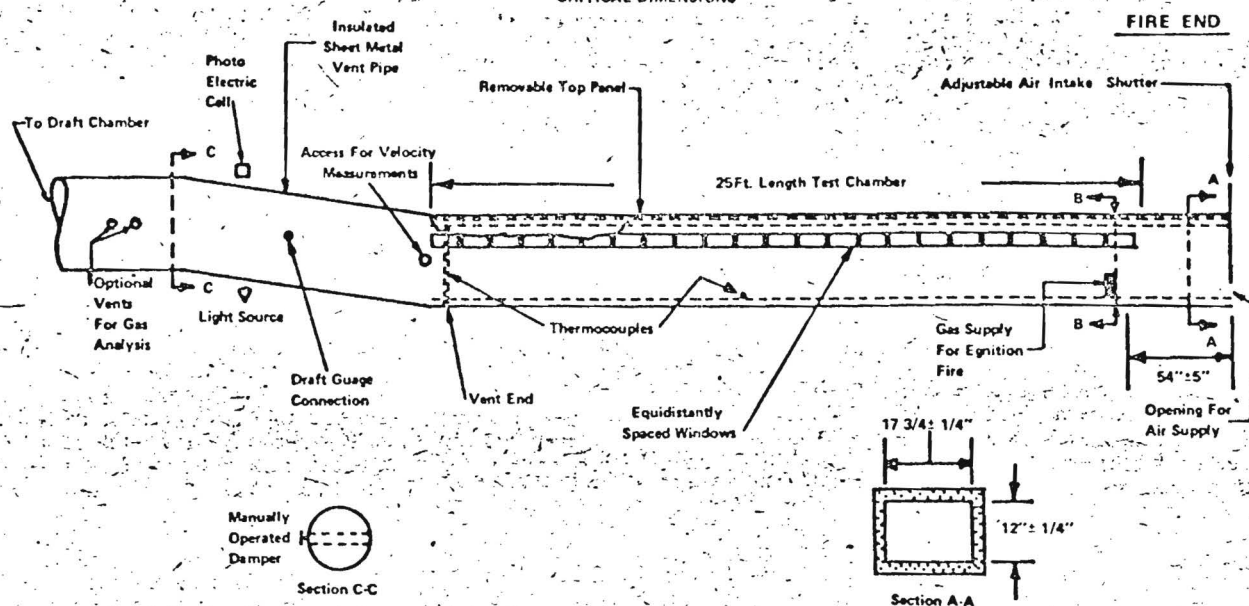
FIG. 1 — TEST FURNACE SHOWING SOME CRITICAL DIMENSIONS

FIG. 2– TEST FURNACE SHOWING SOME CRITICAL DIMENSIONS
(Section B-B NOT A Construction Drawing)

(2) *Ledges in chamber.* The ledges shall be fabricated of structural materials capable of withstanding the abuse of continuous testing, level with respect to the length and width of the chamber and each other, and maintained in a state of repair commensurate with the frequency, volume, and severity of testing occurring at any time. (High temperature furnace refractory zircon has been found suitable for this purpose.)

(3) *Air turbulence.* To provide air turbulence for proper combustion, turbulence baffling shall be provided by positioning six A. P. Green, G-26 refractory firebricks or equivalent (long dimension vertical, 4½ in. (114 mm) dimension along the wall) along the sidewalls of the chamber at distances of 7, 12, and 20±½ ft (2.1, 3.7, and 6.1±0.2 m) on the window side and 4½, 9½, and 16±½ ft (1.3, 2.9, and 4.9±0.2 m) on the opposite side.

(4) *Top of chamber.* The top shall consist of a removable noncombustible (metal and mineral composite) structure, insulated with nominal 3±1 in. (76.2 mm ±25.4 mm) thick mineral compostion material as shown in fig. 2 and of a size necessary to cover completely the fire test chamber and the test samples. The lid shall be maintained in an unwarped and flat condition. The mineral composition material shall have physical characteristics comparable to the following:

Maximum effective temperature: 1200° F (649° C).

Bulk density: 12.5±1.5 lb/ft³ (196.1±24.0 kg/m³.

Thermal conductivity at 300 to 700° F (149 to 371° C): 0.45 to 0.65 Btu·ft/h·ft²·F (0.78 to 1.12 W/m·K).

The entire lid assembly shall be protected with flat sections of high-density (nominal 110 lb/ft³ or 1761 kg·m³) ¼ in. (6.3 mm) asbestos-cement board, maintained in an unwarped and uncracked condition through continued replacement. This protective board may or may not be secured to the furnace lid. When in place the top shall be comletely sealed against the leakage of air into the fire test chamber during the test.

(5) *Gas burners and "fire end" of chamber.* One end of the test chamber, designated as the "fire end," shall be provided with two gas burners delivering flames upward against the surface of the test sample. The burners shall be spaced 12±1 in. (305 mm ± 25.4 mm) from the fire end of the test chamber, and 7½±½ in. (190±13 mm) below the under surface of the test sample. The air intake shutter shall be located 54±5 in. (1372±127 mm) upstream of the burner, as measured from the burner centerline to the outside surface of the shutter. Gas to the burners shall be provided through a single inlet pipe, distributed to each

port burner through a tee-section. The burner outlet shall be a nominal ¾ in. elbow. The plane of the port shall be parallel to the furnace floor, such that the gas is directed upward toward the specimen. Each port shall be positioned with its centerline 4±½ in. (102±13 mm) on each side of the centerline of the furnace so that the flame is evenly distributed over the width of the exposed specimen surface (see fig. 2). The controls used to assure constant flow of gas to the burners during periods of use shall consist of a pressure regulator, a gas meter calibrated to read in increments of not more than 0.1 ft³ (2.8 litres), a manometer to indicate gas pressure in inches of water, a quick-acting gas shut-off valve, a gas metering valve, and an orifice plate in combination with a water manometer to assist in maintaining uniform gas flow conditions. An air intake fitted with a vertically sliding shutter extending the entire width of the test chamber shall be provided at the fire end. The shutter shall be positioned so as to provide an air inlet port 3±⅟₁₆ in. (76±2 mm) high measured from the floor level of the test chamber at the air intake point. (A draft gage tap of the inlet section to indicate static pressure may be inserted through the top at the mid width of the tunnel 1±.5 in. (2.5±1.3 cm) below the ceiling, 15±5 in. (38.1±12.7 cm) downstream from the inlet shutter. If the draft gage is installed in this location it is not necessary to have the draft gage installed in the "vent end" of the chamber described in § 1209.4(a)(6) of this section.)

(6) *"Vent end" of chamber.* The other end of the test chamber, designated as the "vent end," shall be fitted with a gradual rectangular-to-round transition piece, not less than 20 in. (508 mm) in length, with a cross-sectional area of not less than 200 in.² (1290 cm²) at any point. The transition piece shall in turn be fitted to a 16-in. ±¼ in. (406-mm±6.35 mm) diameter flue pipe. The movement of air shall be by an induced draft system having a total draft capacity of at least 0.15-in. (3.8-mm) water column with the sample in place, the shutter at the fire end open the normal 3±⅟₁₆ in. (76±2 mm), and the damper in the wide open position. A draft gage to indicate static pressure shall be joined with the vent pipe using a surface mount connection upstream of the damper and photoelectric cell opening and at a point of minimum air turbulence, at least 16 diameters (approximately 21 ft (6.4 m)) from the vent end of the chamber.

(7) *Light source.* A light source shall be mounted on a horizontal section of the 16-in. (406-mm) diameter vent pipe at a point where it will be preceded by a straight run of pipe (at least 12 di-

ameters or 16 ft (4.88 m) and not more than 30 diameters (40 ft (12.19 m)) from the vent end of the chamber, and with the light beam directed upward along the vertical axis of the vent pipe. (A Weston Instruments No. 856BB Photronic cell and 12-V sealed beam, clear lens, auto spot lamp, with an overall light to cell path length of 36±4 in. (914±102 mm) has been found suitable for this purpose.) The vent pipe shall be insulated with at least 2 in. (51 mm) of high-temperature mineral composition material, from the vent end of the chamber to the photometer location. A photoelectric cell of which the output is directly proportional to the amount of light received shall be mounted over the light source and connected to a recording device having a minimum operating chart width of 5 in. (127 mm) with an accuracy within ±1 percent of full scale, for indicating changes in the attenuation of incident light by the passing smoke, particulate, and other effluent. The distance between the light source lens and the photocell lens shall be 36±4 in. (914±102 mm). The cylindrical light beam shall pass through 3-in. (76-mm) diameter openings at the top and bottom of the 16-in. diameter duct, with the resultant light beam centered on the photocell. (The apparatus described in this section is used for determining smoke developed rating, a measurement that is not required by this interim standard. This equipment is normally used in conjunction with the Steiner Tunnel test apparatus. Although the apparatus described in this section is not used as part of the requirements of the interim standard, the apparatus is included since the removal of the equipment could conceivably cause variability of test results.)

(8) *Damper.* An automatically controlled damper to regulate the draft pressure shall be installed in the vent pipe down-stream of the smoke-indicating attachment. The damper shall be provided with a manual override.

(9) *Other draft regulation devices.* Other manual or automatic draft regulation devices or both may be incorporated to maintain fan characterization and air-flow control throughout test periods.

(10) *Exposed thermocouple.* A No. 18 AWG. (1.02 mm) thermocouple, with ⅜±⅛ in. (9.5±3.2 mm) of the junction exposed in the air, shall be inserted through the floor of the test chamber so that the tip is 1±⅟₃₂ in. (25.4±0.8 mm) below the top surface of the asbestos gasketing tape and 23 ft ±½ in. (7.0 m ±13 mm) from the centerline of the burner ports at the center of its width.

(11) *Embedded thermocouple.* A No. 18 AWG. (1.02 mm) thermocouple embedded ⅛ in. minus 0 in. plus ⅟₁₆ in.

(3.2 mm minus 0 plus 1.59 mm) below the floor surface of the test chamber shall be mounted in refractory or portland cement, carefully dried to avoid cracking, at distances of 13 ft ±½ in. (3.96 m ±13 mm) and 23¼ ft ±½ in. (7.09 m ±13 mm) from the centerline of the burner ports.

(12) *Maintaining atmospheric pressure.* The room in which the test chamber is located shall have provision for a free inflow of air during the test to maintain the room at atmospheric pressure during the entire test run.

(b) *Test specimens.* (1) *Description.* The test specimen shall be at least 2 in. (51 mm) wider (nominally 20¼±¾ in. (514±19 mm)) than the interior width of the tunnel and total 24 ft ±½ in. (7.32 m ±13 mm) in length. The specimen may consist of a continuous, unbroken length, or of sections joined end to end. A 14±⅛ in. (356±3 mm) length of uncoated 16-gage (0.053 to 0.060 in.) steel sheet shall be placed on specimen mounting ledge in front of and under the specimen in the upstream end of the tunnel. Specimens shall be truly representative of the materials for which test results are desired. Properties adequate for identification of the materials or ingredients, or both, of which the test specimen is made shall be recorded.

(2) *Conditioning.* The test specimen shall be conditioned to a constant weight at a temperature of 73.4±5° F (23±2.8° C) and at a relative humidity of 50±5 percent.

(c) *Calibration of test equipment.* (1) *Placement of asbestos-cement board.* Place a ¼±¹⁄₃₂ in. (6.3 mm ±0.8 mm) asbestos-cement board on the ledge of the furnace chamber, then place the removable lid of the test chamber in position. The asbestos-cement board shall be nominal ¼ in. (6.3 mm) thick, high density (110±5 lb/ft³ (1,762±80 kg/m³) and uncoated. (In handling the asbestos-cement board, appropriate precautions should be taken to avoid unnecessary inhalation of dust from the asbestos-cement board.)

(2) *Controlling air leakage.* With the ¼-in. (6.3 mm) asbestos-cement board in position on top of the ledge of the furnace chamber and with the removable lid in place, establish a draft to produce a 0.15-in. (3.8 mm) water-column reading on the draft manometer, with the fire-end shutter open 3±¹⁄₁₆ in. (76±1.6 mm), by manually setting the damper as a characterization of fan performance. Then close and seal the fire-end shutter, without changing the damper position. The manometer reading shall increase to at least 0.375 in. (9.53 mm), indicating that no excessive air leakage exists.

In addition, conduct a supplemental leakage test periodically with the fire shutter and exhaust duct beyond the differential manometer tube sealed, by placing a smoke bomb in the chamber. Ignite the bomb and pressurize the chamber to 0.375±0.125 in. (9.53±3.18 mm) water column. Seal all points of leakage observed in the form of escaping smoke particles.

(3) *Air velocity.* Establish a draft reading within the range 0.055 to 0.085 in. (1.40 to 2.16 mm) water column. (The draft reading shall be within the range .085 to .100 in. (2.16 to 2.54 mm) water column if the draft gage tap is inserted through the top at the "fire end" of the tunnel, as allowed by § 1209.4(a)(5).) The required draft gage reading will be maintained throughout the test by the automatically controlled damper. Record the air velocity at seven points, 23 ft ±1 in. (7 m ±25.4 mm) from the centerline of the burner ports, 6±¼ in. (168±7 mm) below the plane of the specimen mounting ledge. Determine these seven points by dividing the width of the tunnel into seven equal sections and recording the velocity at the geometrical center of each section. During the measurement of velocity, remove the turbulence bricks (see § 1209.4(a)(3)) and exposed 23 ft thermocouple and place 24 in. ±1 in. (670-mm ±25.4 mm) long straightening vanes between 16 and 18 ft (4.88 and 5.49 m) from the burner. The straightening vanes shall divide the furnace cross section into nine uniform sections. Determine the velocity with furnace air temperature at 73.4±5° F (23±2.8° C), using a velocity transducer. (A Thermo Systems, Inc. Model 1610 velocity transducer (thermal anemometer) using a readout device accurate to 0.001-V, has been found suitable for the purpose.) The velocity, determined as the arithmetic average of the seven readings, shall be 240±5 ft (73.2±1.5 m) /min.

(4) *Temperature and relative humidity of air supply.* Maintain the air supply at a temperature of 73.4±5° F (23±2.8° C), and a relative humidity of 50±5 percent.

(5) *Gas supply.* Supply the fire test chamber with natural (city) or methane (bottled) gas fuel of uniform quality with a heating value of nominally 1,000 Btu/ft³ (37.3 MJ/m³). Adjust the gas supply initially at approximately 5,000 Btu (5.3 MJ)/min. Record the gas pressure, the pressure differential across the orifice plate, and the volume of gas used in each test. Unless otherwise corrected for, when bottle methane is employed, insert a length of coiled copper tubing into the gas line between the supply and metering connection to compensate for possible errors in the flow indicated due to reductions in gas temperature associated with the pressure drop and expansion across the regulator. With the draft and gas supply adjusted as indicated in 1209.4(c) (3) and (4), the test flame

shall extend downstream to a distance of 4½ ft ±6 in. (1.37 m ±152.5 mm) over the specimen surface, with negligible upstream coverage.

(6) *Preheating of test chamber.* Preheat the test chamber with the ¼ in. (6.3 mm) asbestos-cement board and the removable lid in place and with the fuel supply adjusted to the required flow. Continue the preheating until the temperature indicated by the floor thermocouple at 23¼ ft (7.09 m) reaches 150±5° F (66±2.8° C). During the preheat test, record the temperatures indicated by the thermocouple at the vent end of the test chamber at intervals not longer than 15 s and compare these readings to the preheat temperature shown in the time-temperature curve in figure 3. This preheating is for the purpose of establishing the conditions that will exist following successive tests and for indicating the control of the heat input into the test chamber. If appreciable variation from the temperatures shown in the representative preheat curve is observed, suitable adjustments in the fuel supply may be necessary based on red oak calibration tests.

(7) *Cooling.* Allow the furnace to cool after each test. When the floor thermocouple at 13 ft (3.96 m) shows a temperature of 105±5° F (40.5±2.8° C), place the next specimen in position for test.

(8) *Tests with red oak flooring.* With the test equipment adjusted and conditioned as described in §§ 1209.4(c) (3), (4), and (6), make a test or series of tests, using nominal ²⁵⁄₃₂ in. (19.8 mm) select-grade red oak flooring as a sample, conditioned to 6 to 8 percent moisture content as determined by the 221° F (105° C) oven/dry method described at § 1209.8. Make observations at distance intervals not in excess of 2 ft ±6 in. (0.6 m ±152.4 mm) and time intervals not in excess of 30 s, and record the time when the flame reaches the end of the specimen, that is, 19½ ft (5.94 m) from the end of the ignition fire. The end of the ignition fire shall be considered as being 4½ ft (1.37 m) from the burners. The flame shall reach the end point in 5½ min ±15 s. Automatically record the temperatures measured by the thermocouple near the vent end at least every 15 s.

The flame may be judged to have reached the end point when the vent-end thermocouple registers a temperature of 980° F (527° C).

(9) *Steel screen correction factor.* Prior to performing the surface burning test, the operator shall develop a correction factor for the select grade red oak flooring with the steel screening, as described in § 1209.4(d)(1), in place. The placement and fastening of the screening to the select grade red

oak flooring shall be as shown in figure 4.

(10) *Recording flame spread distance.* Plot the flame spread distance and temperature readings separately on suitable coordinate paper. Figures 5 and 6 are representative curves for red oak flame spread distance and time temperature development. Flame spread distance shall be determined as the observed distance minus 4½ ft (1.37 m).

(11) *Tests with asbestos-cement board.* Following the calibration tests for red oak, conduct a similar test or tests on samples of ¼ in. (6.3 mm) asbestos-cement board. These results shall be considered as representing a classification of 0. Plot the temperature readings separately on suitable coordinate paper. Figure 7 is a representative curve for time temperature development for asbestos-cement board. (In handling the asbestos-cement board, appropriate precautions should be taken to avoid unnecessary inhalation of dust from the asbestos-cement board.)

(d) *Procedures.* (1) *Placement of specimen.* Loose fill insulation shall be placed on steel screening with wires nominally 0.01±0.001 in. (0.254 mm ±0.0254 mm) in diameter with approximate ³⁄₆₄ in. (1.2 mm) openings supported on a test frame 20±¼ in. (508 mm ±6.35 mm) wide by 2±¹⁄₁₆ in. (51 mm ±1.59 mm) deep, made from nominally 2 by 3 by ³⁄₁₆ in. (51 by 76 by 5 mm) steel angles. Three frames are required. See figure 8. The insulation shall be packed to the density specified by the manufacturer. If the manufacturer fails to specify the density of the insulation, the Commission shall determine the density of the insulation by using the blown in and/or poured density test method at § 1209.7.

The Commission shall then pack the insulation to the density obtained by using the test method at § 1209.7. With the furnace draft operating, place the test specimen on the test chamber ledges which have been completely covered with nominal ⅛ in. (3.2 mm) thick by 1½ in. (38 mm) wide woven asbestos tape. Place the specimen as quickly as is practical. Place the removable top in position over the specimen.

(2) *Furnace draft.* The completely mounted specimen shall remain in position in the chamber with the furnace draft operating for 120±15 s prior to the application of the test flame.

(3) *Flame front distance.* Ignite the burner gas. Observe and record the distance and time of maximum flame front travel with the room darkened. Continue the test for a 10-min period ±2 sec. The test may be terminated prior to 10 min if the specimen is completely consumed in the fire area and no further progressive burning is evident.

(4) *Gas.* Record the gas pressure, the pressure differential across the orifice plate, and the volume of gas used in each test.

(5) *Conclusion of test.* When the test is ended, shut off the gas supply, observe smoldering and other conditions within the test duct, and remove the specimen for further examination.

(6) *Recording flame spread.* Plot the flame spread distance and temperature readings separately on the same type of coordinate paper as used in § 1209.4(c)(10) for use in determining the flame-spread classification as outlined in § 1209.4(e). The flame spread observations must be recorded at distance intervals not in excess of 2 ft (0.6 m) or time intervals not in excess of 30 s. In addition, the peak must be noted with the time of occurrence.

Flame spread distance shall be determined as the observed distance minus 4½ ft (1.37 m).

(e) *Classification.* (1) *Method for determining flame spread classification (FSC).* (i) The total area (A_T) under the flame spread time-distance curve shall be determined by ignoring any flame front recession. For example, in figure 9 the flame spread 10 ft (3.05 m) in 2½ min and then recedes. The area is calculated as if the flame had spread to 10 ft in 2½ min and remained at 10 ft for the remainder of the test or until the flame front again passed 10 ft. This is shown by the dashed line in figure 9. The area (A_T) used for calculating the flame spread classification is the sum of areas A_1 and A_2 in figure 9.

(ii) If this total area (A_T) is less than or equal to 97.5 min. ft, the flame spread classification shall be 0.564 times the total area ($FSC = 0.564 A_T$).

(iii) If the total area (A_T) is greater than 97.5 min. ft, the flame spread classification shall be 5363, divided by the difference of 195 minus the total area (A_T). ($FSC = 5363/(195-A_T)$.)

(iv) The correction factor described in section 1209.4(c)(9) shall be used in reporting the surface burning characteristics (flame spread classification) of cellulosic fiber loose-fill, thermal insulation conforming to this specification.

(f) *Report.* The report shall include the following:

(1) Description of the material being tested,

(2) Test results as calculated in § 1209.4(e),

(3) Details of the method used in placing the specimen in the test chamber, and

(4) Observations of the burning characteristics of the specimen during test exposure, such as sagging and fallout.
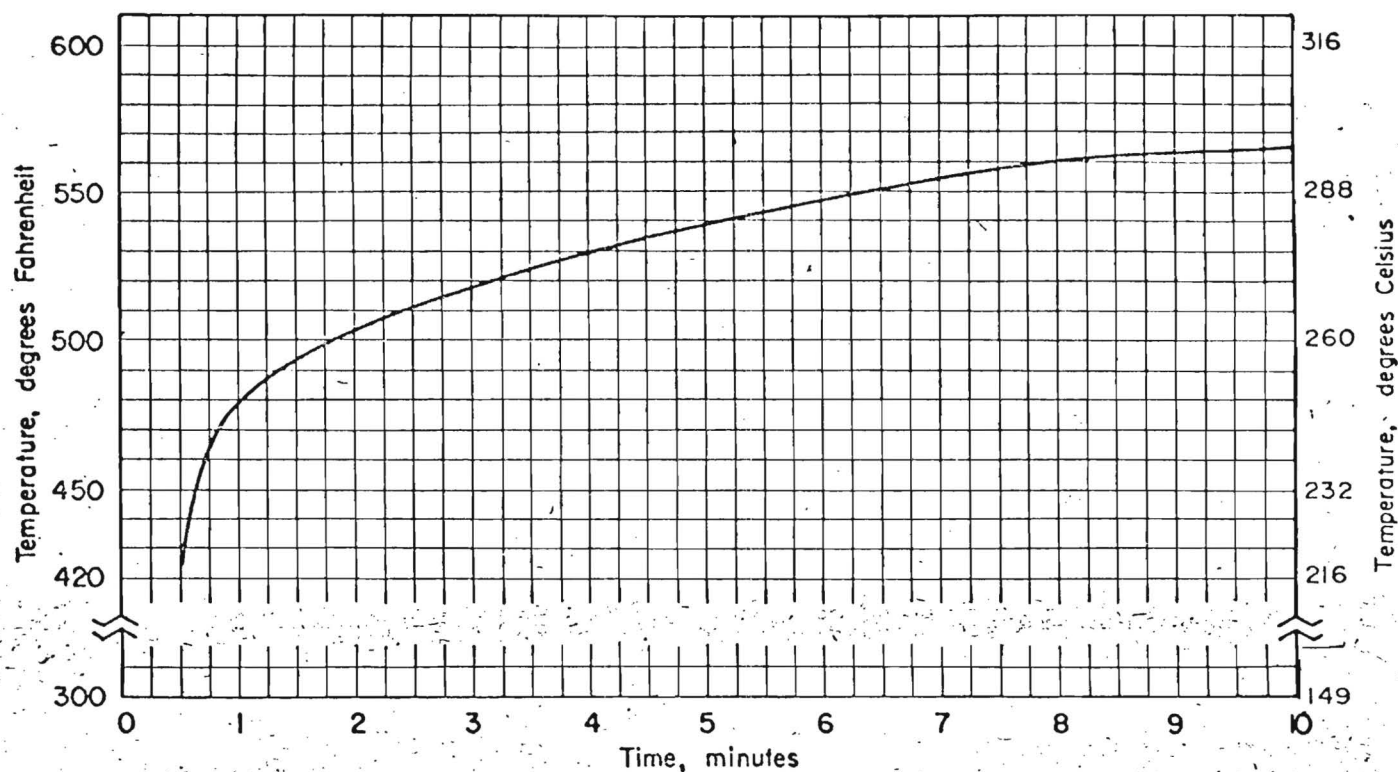
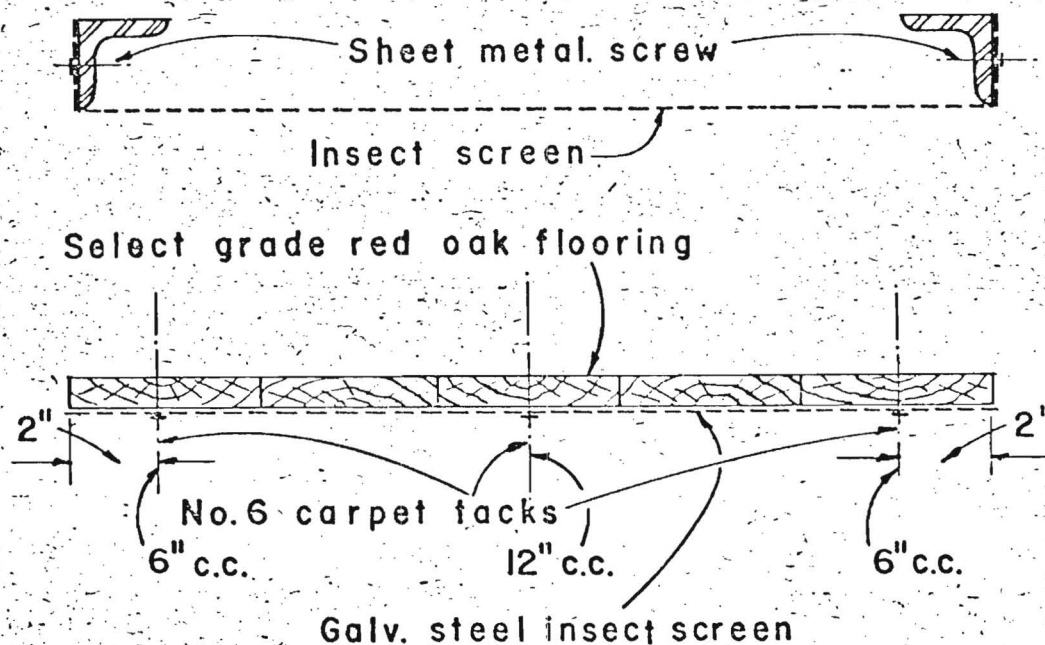**FIG.3 — TIME—TEMPERATURE CURVE FOR PREHEAT TEMPERATURE**

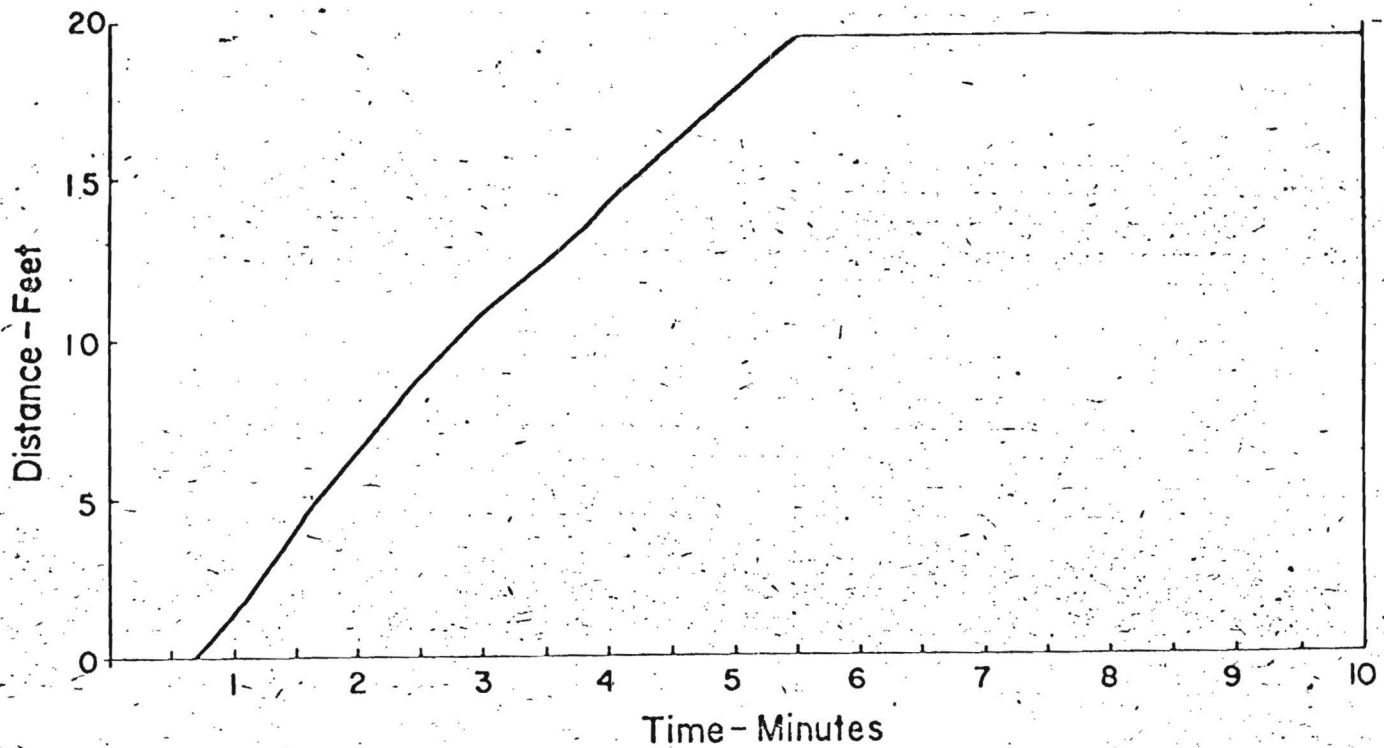**FIG.4 — PLACEMENT AND FASTENING OF SCREENING TO SELECT GRADE RED OAK FLOORING**
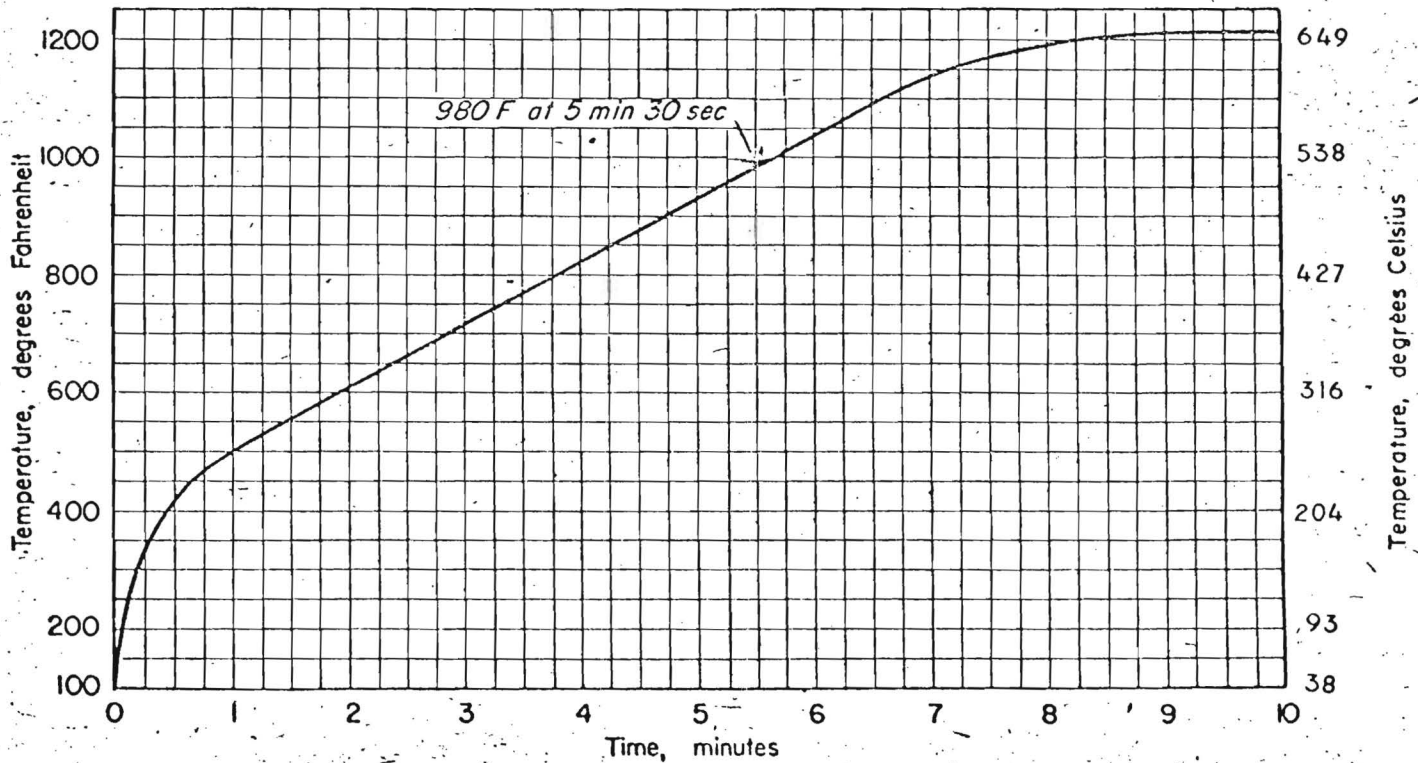
FIG.5 — TIME—DISTANCE CURVE FOR FLAME SPREAD OF RED OAK

980 F at 5 min 30 sec

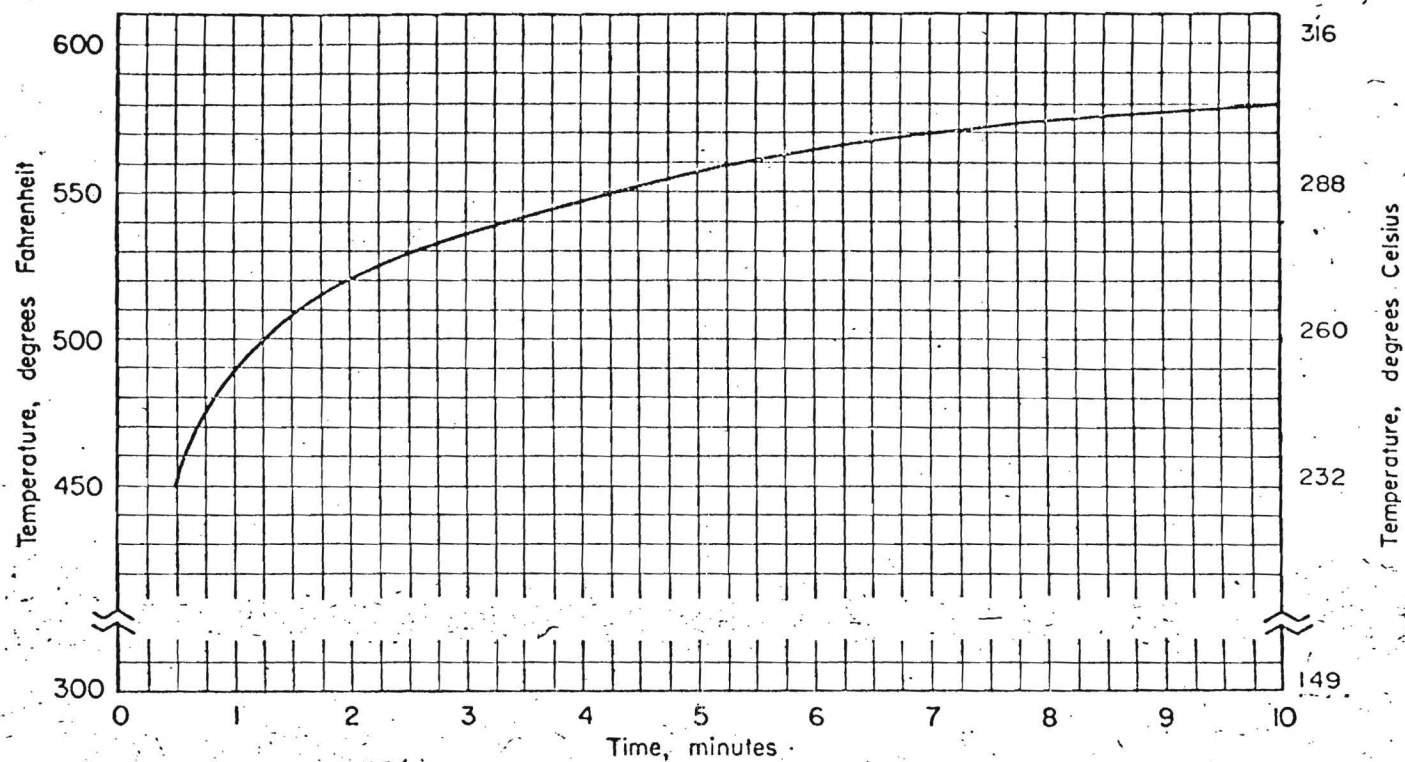**FIG.6 — TIME—TEMPERATURE CURVE FOR FUEL CONTRIBUTION OF RED OAK**

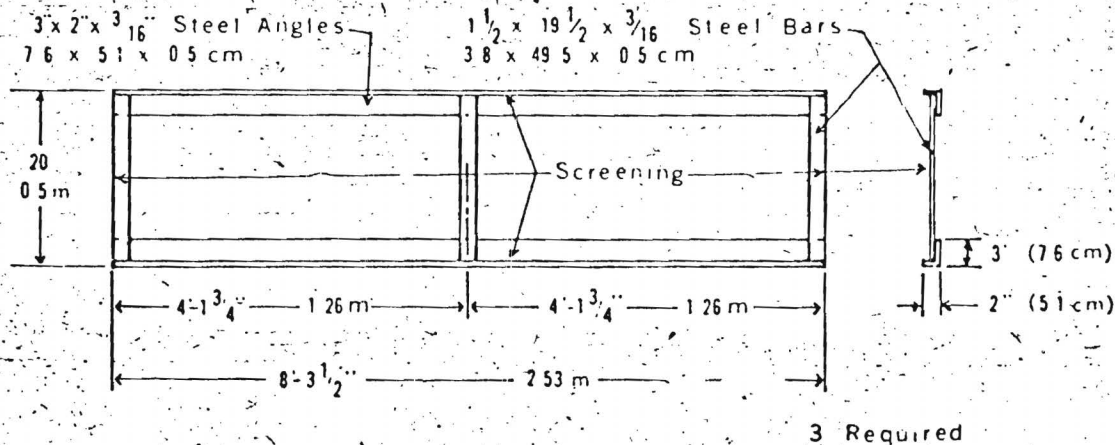**FIG.7 — TIME—TEMPERATURE CURVE FOR CONTRIBUTION OF ASBESTOS—CEMENT BOARD**
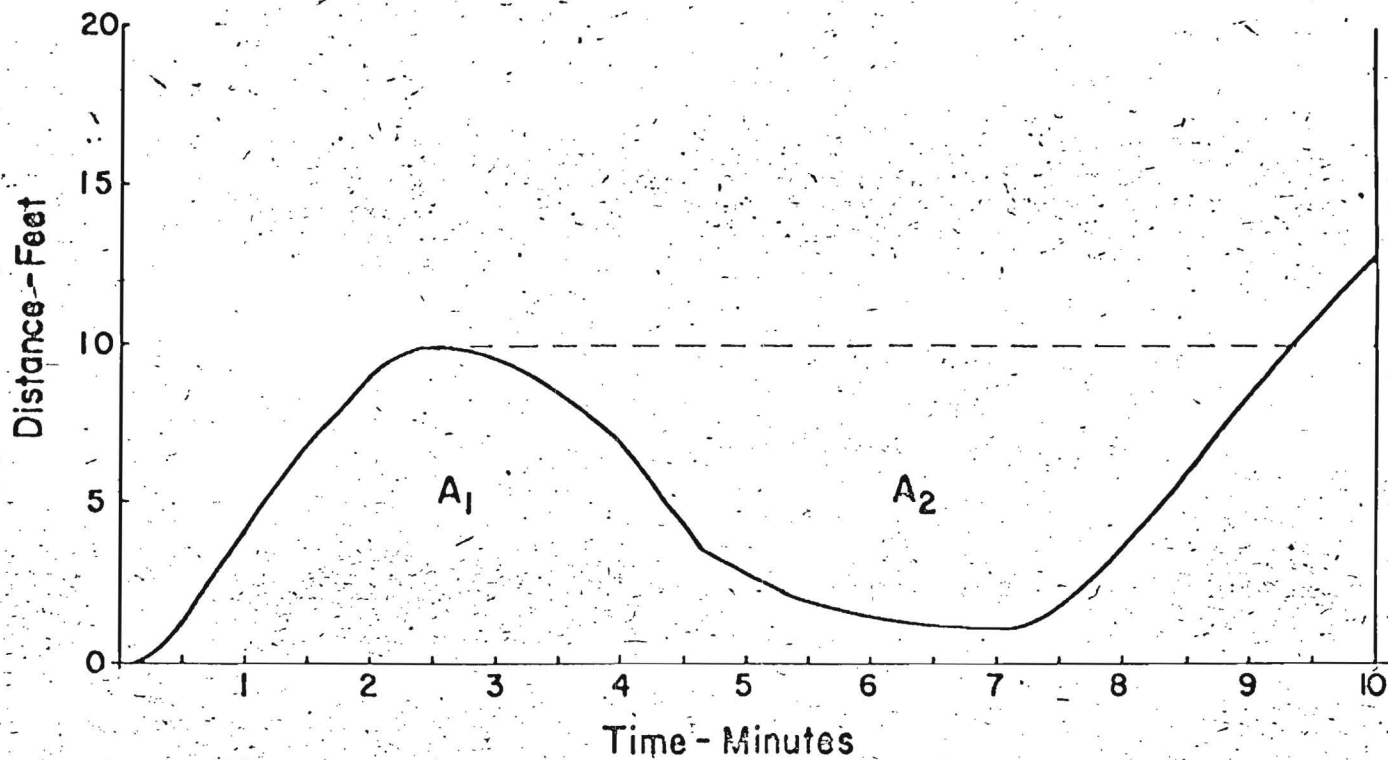

FIG.8

FIG.9 — EXAMPLE OF TIME—DISTANCE CURVE WITH FLAME
FRONT RECESSION

§ 1209.5 Test procedures for flame resistance permanency.

(a) *Apparatus.* (1) *Humidity chamber.* Humidity chamber capable of maintaining 180±3° F (82.2±1.7° C) with 96±3 percent relative humidity for high-temperature conditioning and 80±3° F (26.7±1.7° C) with 50±3 percent relative humidity for low-temperature conditioning.

(2) *Flame spread test apparatus, 2 ft.* A detailed description of this apparatus with construction drawings appears in an article by Vandersall, H. L. "The Use of a Small Flame Tunnel for Evaluating Fire Hazard," *Journal of Paint Technology,* JPTY, vol. 39, No. 511, August 1967, pp. 494-500. (A copy of this article is available at the Commission's Office of the Secretary, Third Floor, 1111 18th Street NW., Washington, D.C. 20207.) A Custom Scientific Instrument (CSI) 2-ft flame spread test tunnel (Model C-196 CL) has been found satisfactory for this purpose. When a material's flame spread rating as found in § 1209.4 is within 20 percent of a higher classification, a 25-ft tunnel must be used in place of the 2-ft apparatus.

(3) *Laboratory scales.* The scales must be capable of weighing to the nearest 0.1 g.

(b) *Procedure.* (1) *Specimens.* (i) Submit a representative sample of the insulation for test, portions of which shall be used for each test.

(ii) Prepare two specimens of at least 100 g each and not less than 2 in. (51 mm) thick.

(iii) Condition specimens for 24 hr at 80±3° F (26.7±1.7° C) and 50±3 percent relative humidity.

(iv) Conduct a flame spread and fuel contribution test on one specimen in the 2-ft apparatus and record the results.

The screening used to support the specimen properly shall be in accordance with § 1209.4(d)(1). The 2-ft apparatus shall be calibrated and operated as outlined in H. L. Vandersall's article.[1]

(v) Age the second specimen in the humidity chamber as follows:

24 hr at 180±3° F (82.2±1.7° C) and 96±3 percent relative humidity.
24 hr at 80±3° F (26.7±1.7° C) and 50±3 percent relative humidity.
24 hr at 180±3° F (82.2±1.7° C) and 96±3 percent relative humidity.
24 hr at 80±3° F (26.7±1.7° C) and 50±3 percent relative humidity.

(vi) Conduct a flame spread and fuel contribution test on the aged specimen.

[1] This article is incorporated by reference. The incorporation by reference provision was approved by the Director, Office of the Federal Register, on July 31, 1978. A copy of this article is available at the Commission's Office of the Secretary, Third Floor, 1111 18th Street NW., Washington, D.C. 20207 and is on file at the Office of the Federal Register.

(c) *Report.* The report shall include the following:

(1) Temperatures, relative humidity, and exposure times of aging procedure.

(2) A numerical determination is made of the flame spread and fuel contribution of the aged specimen and the non-aged specimen. When there is an increase in flame spread of 20 percent or more of the aged specimen in the 2-ft apparatus, the flame resistance permanency test must be repeated using the test method specified at § 1209.4.

(3) A change in flame spread classification in the 25-ft tunnel as modified in this standard shall constitute failure of the test.

§ 1209.6 Test procedures for corrosiveness.

(a) *Apparatus and materials required for the test.* (1) *Humidity chamber.* Humidity chamber capable of maintaining 120±3° F (48.9±1.7° C) and 96±3 percent relative humidity.

(2) *Evaporating dishes.* Evaporating dishes, two, 90 mm by 50 mm.

(3) *Test specimens.* Test specimens, two each, 2 by 2 in. (50.8 by 50.8 mm) by 0.003 in. (0.762 mm) thick metal free of tears, punctures, or crimps as follows:

(i) 2024-T3 Bare Aluminum.

(ii) ASTM B 152, Type ETP, Cabra No. 110, soft copper.

(iii) Low carbon, commercial quality, cold rolled, shim steel.

(4) *Trichloroethylene or 1,1,1,-Trichloroethane.* Analytical reagent trichloroethylene or 1,1,1,-trichloroethane.

(b) *Specimen.* A representative sample of the insulation shall be submitted for test, portions of which shall be used for each test.

(c) *Test procedure.* (1) Wash the metal specimens with 1,1,1-trichloroethane to remove any oil or grease. Dry at room temperature.

(2) Presaturate the insulation samples by mixing 20 g of insulation with 150 ml of distilled water at room temperature for each test specimen.

(3) Place a ½-in. (12.7 mm) thick layer of saturated insulation into an evaporating dish, tamp level, and place metal specimen on the insulation. Cover the metal specimen with the remaining insulation and tamp to assure good contact with the metal plate. Cover with nonmetallic screen to prevent spilling during test.

(4) Place the composite specimens and a control metal specimen into the humidity chamber, calibrated at 120° F (48.9° C) and 96±3 percent relative humidity, for 168 hr.

(5) Upon completion of the test, thoroughly wash the metal specimens under running water and lightly brush them to remove loose corrosion products. Remove the remaining corrosion products by immersing them in 10 parts distilled water and 1 part nitric acid, 15.9 N. Rinse the samples in water and dry.

(6) Make two duplicate tests for each determination.

(d) *Report.* The report shall include the following:

(1) Temperature, relative humidity, and exposure time.

(2) Comparison of corrosion between insulated panel and control panel. When minor surface etching occurs on the insulated aluminum or copper panels, extended 30-day tests shall be conducted to determine additional corrosion effect. Extended 30-day tests shall be conducted on the steel panel only when corrosion of the insulated steel panel compares unfavorably with that of the control steel panel.

(3) Noncorrosiveness shall be determined by the absence of any perforations when the metal specimen is observed over a chrome reflected 40-W appliance light bulb.

§ 1209.7 Test procedures for density.

(a) *Apparatus.* (1) *Loose fill insulation container.* The container shall consist of a wooden container whose inside dimensions shall not be less than 18×14×4 in. (457 by 355 by 102 mm). The container should be closed on the bottom of the large area side and open on the other side to permit filling.

(2) *Scales.* Scales with an accuracy of at least 0.5 percent of the sample weight.

(3) *Blowing machine.* A blowing machine with 150 ft (46 m) of 2½ in. (64 mm) diameter flexible corrugated standard blower hose. A blowing machine manufactured by the Universal Insulation Co., Van Wert, Ohio has been found satisfactory for this purpose.

(b) *Specimens.* Three bags or containers of the loose fill insulation shall be selected from the material to be tested.

(c) *Conditioning.* Condition samples for at least 24 hr at 50±2 percent relative humidity and 73±° F (23±1.1° C) and test under ambient conditions.

(d) *Specimen preparation.* (1) *Blown specimens.* (To be used when fibrous insulations are recommended by the manufacturer for installation by blowing.)

(i) The loose fill insulation container shall be located on a level floor in front of an operator directing the blowing hose.

(ii) The horizontal distance between the end of the flexible hose from which the insulation is blown and the container shall be between 7 and 8 ft (2.1 and 2.4 m).

(iii) The flexible hose shall be 2½ in. (64 mm) in diameter, held in a horizontal position, and approximately 3 ft

(0.9 m) above the surface upon which the container is resting.

(iv) Feed a package of insulation into the hopper of the blowing machine. Blowing time will vary, depending upon the size of the package containing the insulation.

(v) When the velocity of the insulation being blown is sufficient to fill the container, make the specimen.

(vi) Level off the top surfaces of the blown sample by hand. The nature of blown insulation is such that it cannot be screened as is done with sand; therefore, take care not to compact the insulation or leave large voids in the surface of the material.

(2) *Poured specimens.* In those instances where fibrous loose fill insulation is recommended only for pouring in place, open the package of insulation and pour directly into the loose fill insulation container and level off as described in § 1209.7(d)(1)(vi).

(e) *Procedure.* (1) After the container of loose fill insulation has been prepared, determine the insulation thickness. Use the volume determined using this average thickness along with the insulation weight to calculate the density, D.

(2) Using fresh material, repeat the test for a total of three times.

(3) Determine the tare weight of the insulation container by placing the empty container on the scales (§ 1209.7(a)(2)) and reading the weight. After the filling and screening operations, reweigh the insulation filled container. Calculate the insulation weight in pounds.

(f) *Calculations.* (1) Calculate the insulation weight, W_1, as follows:

$$W_1 = W_F - W_T$$

where:

W_1 = insulation weight, lb (kg),
W_F = weight of filled container, lb (kg), and
W_T = weight of empty container, lb (kg).

(2) Calculate the density from the average thickness as follows:

$$D = W_1/V$$

where:

D = density, lb/ft³ (kg/m³),
W_1 = weight of insulation, lb (kg), and
V = Volume of container, ft³ (m³).

(g) *Report.* Report the density in pounds per cubic foot for each test, and the average of the three tests, along with the method of sample preparation that is, blown or poured.

§ 1209.8 **Test procedures for determining the moisture content of wood.**

(a) *Apparatus.*—(1) *Oven.* An oven that can be maintained at a temperature of 103±2° C (217.4±3.6° F) throughout the drying chamber for the time required to dry the specimen to constant weight. Ovens may require forced-air circulation to maintain uni-

form temperature. An accurate thermometer or pyrometer shall be used to check the temperature. For convenience, ovens will normally be thermostatically controlled. Ovens shall be vented to allow the evaporated moisture to escape. --

(2) *Weighing device.* A scale or balance that will weigh a specimen within accuracy of ±0.2 percent. The accuracy and sensitivity of the weighing apparatus shall be checked at least every year against standard weights. Knife edges shall be kept clean to assure accuracy. A torsion balance, Harvard trip balance, triple beam balance, and automatic direct-reading balance are examples of suitable equipment.

(b) *Test specimens.* Specimens vary widely, depending on the type of material being analyzed and the anticipated use of the results. Specimens shall be selected that represent the lot. Unless otherwise specified, specimens shall be full cross sections no less than 25 mm (1 in.) along the grain, but longer as needed to provide a minimum volume of 33 cm³ (2 in.³). The section shall be cut with a sharp saw. All loosely attached slivers shall be removed from the section before it is weighed. Specimens from large items such as logs, poles, posts, piling, and timbers shall be: (1) Full cross sections, (2) representative sectors of such sections, (3) increment core borings, or (4) auger chips. When the latter two types of specimens are used on round items to represent the average moisture content of the sample, they shall be divided into zones and a weighted average moisture content determined arithmetically from the relative proportion of the cross section each zone represents. Because of the small volume of borings and auger chips, a more sensitive balance is required than would be required for specimens cut from lumber and other sawed items.

(c) *Procedure.*—(1)·*Initial weighing.* Weigh each specimen immediately after cutting from the sample representing the lot or else protect it from a moisture change until weighed. Weigh each specimen to an accuracy of ±0.2 percent, for example, if the specimen weighs 250 g, obtain the weight to the nearest 0.5 g. Record the weight either on the specimen or on a data sheet that is numbered to correspond with the number on the specimen. If a delay between cutting the specimen and weighing cannot be avoided, place the specimen in a vapor-tight container or wrapper immediately upon cutting and allow it to remain in the container or wrapper until it can be weighed. Suitable wrappers can be made of aluminum foil or polyethylene film. The delay between cutting and weighing of the protected specimen shall be as short as possible, but

in no case to exceed 2 h. Obtaining weights in grams rather than in grains or ounces simplifies calculations.

(2) *Drying.* After they have been weighed, place the specimens in an oven when convenient and heat at 103±2 C (217.4±3.6 F) until they reach constant weight. Place the specimens in the oven in a manner that will allow free access of heated air to each. To test for constant weight, weigh the heaviest specimens at intervals of 2 h or more until they show no further weight loss within the accuracy of weighing required. Avoid drying for periods longer than necessary to achieve constant weight since prolonged distillation or oxidation of the wood will produce a weight loss reflecting a higher-than-actual moisture content. Newly cut specimens should not be placed in the oven with partially dried ones since the drier specimens will be retarded in drying.

As a guide, an air-dry specimen about 50 by 100 mm (2 by 4 in.) in cross section and 25 mm (1 in.) along the grain will usually attain constant weight within 24 h at the specified temperature when dried in an electric oven having good forced-air circulation.

(3) *Final weighing.* Weigh each specimen immediately after it is removed from the oven upon attaining constant weight or store in a desiccator while awaiting weighing. The accuracy shall be the same as required for initial weighing.

Calculation. Calculate the moisture content as follows:

Moisture content, percent = $[(A-B)/B] \times 100$
or, for more convenient slide rule or computer calculation:

Moisture content, percent = $((A/B)-1) \times 100$

where:

A = original weight, and
B = oven-dry weight.

Example A 25-mm (1-in.) specimen of lumber weighed 56.7 g. After oven-drying, the weight was 52.3 g.

Moisture content, percent
= $[(56.7-52.3)/52.3] \times 100$
= $(4.4/52.3) \times 100 = 8.4$ percent.

If wood has been treated with a waterborne nonvolatile chemical and if the weight of the retained chemical is known, the moisture content may be determined as follows:

Moisture content, percent = $[(A-B)/D] \times 100$
where $D = B$ — weight of retained chemical in sample.

§ 1209.9 **Labeling requirements.**

(a) Manufacturers and private labelers of cellulose insulation shall place on all containers of cellulose insulation the following statement: "Attention: This material meets the applicable minimum Federal flammability standard. This standard is based upon laboratory tests only, which do not

represent actual conditions which may occur in the home." Manufacturers and private labelers may use a pressure sensitive or glued-on label to meet this requirment provided the label is made and attached in such a manner that it will be legible for the expected amount of time between the manufacture of the product and its installation.

(b) This statement shall appear prominently and conspicuously on the cellulose insultation container and shall appear in conspicuous and legible type in contrast by typography, layout, and color with other printed matter on the container. CPSC regulations at 16 CFR 1500.121 provide type size, placement, and other requirements for cautionary labeling under the Federal Hazardous Substances Act (FHSA) (15 U.S.C. 1261). Those regulations indicate how labeling can meet the requirements of the FHSA that labeling appear prominently and conspicuously on the label of a hazardous substance. The Commission suggests that the FHSA regulations at 16 CFR 1500.121 be used as guidelines as to whether the labeling required in this standard is prominent, conspicuous, and legible.

§ 1209.10 Certification and enforcement.

(a) While this part 1209 prescribes test methods to determine whether cellulose insulation subject to this interim standard meets the requirements of the interim standard, the interim standard itself does not require that a manufacturer test any cellulose insulation subject to the interim standard. However, section 14 of the Consumer Product Safety Act requires manufacturers and private labelers of products subject to safety standards to certify that the product conforms to the standard, based on either a test of each product or a reasonable testing program. Manufacturers and private labelers must establish a testing program that is adequate to insure that the product being produced and distributed conforms to this interim standard. In the future, the Commission may issue regulations as to what constitutes a reasonable testing program.

(b) The Commission intends to use the test procedures set forth in this part 1209 to determine whether insulation subject to the interim standard meets the requirements of the interim standard.

§ 1209.11 Effective date.

All cellulose insulation that is a consumer product and that is manufactured after September 7, 1978, must meet the requirements of this standard, including the labeling requirement of § 1209.9.

Dated: August 2, 1978.

SHELDON D. BUTTS,
Acting Secretary, Consumer Product Safety Commission.

[FR Doc. 78-22034 Filed 8-7-78; 8:45 am]

United States Testing Company, Inc.

California Division

5521 TELEGRAPH ROAD, LOS ANGELES, CALIFORNIA 90040

(213) 723-7181 • (213) 722-0608

REPORT OF TEST

SOLAR ENERGY CONTROL, INC.
1017 Trotwood Drive
Lexington, Ky. 40511

FLAME SPREAD CLASSIFICATION;
SMOKE AND FUEL CONTRIBUTION

CELLULOSIC LOOSE-FILL
FIBER INSULATION

April 25, 1977

James H. Heywood
Test Engineer

P. McCullen
Test Technician

TEST REPORT NO. LA 70203

SIGNED FOR THE COMPANY

BY Bernd S. Givon
Professional Engineer

Laboratories in: New York • Chicago • Los Angeles • Houston • Tulsa • Memphis • Reading • Richland

REFERENCE

Order for Test dated 4/1/77 per Mr. Jack Belcher

REQUIREMENT

To determine conformance with Fed. Spec. HH-I-515C for:

A. Standard flame spread, smoke density and fuel
contributed classification tests on loose fill
insulation supplied by the Client in accordance
with ASTM Designation E-84 "Standard Method of
Test for Surface Burning Characteristics of
Building Materials".

B. Flame Resistance Permanency Tests in accordance
with ASTM Designation C-739 "Standard Specification
for Cellulosic Fiber (wood base) Loose-Fill Insulation".

SAMPLE IDENTIFICATION

The sample tested was submitted and identified by
the Client as:

> Cellulosic Loose-Fill
>
> Fiber Insulation
>
> Applied at 2.0 lbs./cu. ft.
>
> Density.

TEST PROCEDURES

A. Flame Spread Classification

The insulation was tested following calibration and preheating. The evaluation was performed in conformance with the specifications set forth in ASTM Designation E-84, both as to equipment and test procedure. The foregoing test procedure is comparable to UL 723, NFPA No. 255 and UBC No. 42-1.

The loose fill insulation was placed on galvanized steel screening with approximate 3/64 in. openings supported on a test frame 20 in. wide by 2 in. deep, made from 2 by 3 by 3/16 in. steel angles. The insulation was then packed into the frame at the density specified by the Client.

Prior to filling the frames, the loose fill material was circulated three (3) times through an industrial vacuum in order to "fluff" the material and to obtain the desired density for testing.

The filled test frames were placed in the conditioning room (maintained at a dry bulb temperature between 70° and 75°F and a relative humidity between 35 and 40 percent) and allowed to come to equilibrium.

TEST PROCEDURES (Cont.)

B. Flame Resistance Permanency

The loose fill insulation was evaluated for Flame
Resistance Permanency in accordance with ASTM C-739,
para. 10.4, whereby samples of the insulation were
placed in trays of galvanized steel screening and
alternately cycled under conditions of 180 ± 3°F and
96 ± 3% relative humidity and 80 ± 3°F and 50 ± 3%
relative humidity. Exposure time under each condition
was 24 hours per cycle for a total time of 96 hours
accelerated aging.

The material was tested in the original condition and
after the accelerated aging procedure described above to
compare its horizontal burn rate and thus determine the
Flame Resistance Permanency.

The test chamber utilized is that described in Federal Test
Method Std. 191, Method 5906, Horizontal Burn Rate. For
this purpose a specimen holder was constructed of galvanized
steel screening 2 in. wide by 2 in. deep by 12 in. long and
covered with an asbestos/cement board lid permitting exposure
of the bottom of the test specimen and containing thermo-
couples to measure the heat generation.

TEST PROCEDURES (Cont.)

B. Flame Resistance Permanency (Cont.)

The tests were performed in triplicate for each condition and the averages of the char length and heat generation by temperature rise are reported.

Note:

An increase of char length of 20% or more of the aged specimen in the small scale test requires the flame resistance permanency test to be repeated using the ASTM Method E-84: 25 ft. tunnel procedure.

SUMMARY OF TEST RESULTS

A. Flame Spread per ASTM E-84

Because of the possible variations in reproducibility, the results are adjusted to the nearest figure divisible by 5.

1. For this sample of loose-fill cellulose fiber insulation:

Flame Spread		Fuel Contribution	Smoke Density
Formula	Area		
10	10	0	0

2. The corresponding Building Materials Surface Burning Classifications* are:

NFPA - Class A

UBC - Class I

*NFPA CLASS	UBC CLASS	FLAME SPREAD
A	I	0 through 25
B	II	26 through 75
C	--	76 through 200
-	III	76 through 225
D	--	201 through 500
E	--	Over 500

BUILDING CODES CITED

1. National Fire Protection Association, NFPA No. 101, "Life Safety Code".

2. UNIFORM BUILDING CODE, Part VIII, "Fire Resistive Standard for Fire Protection".

   Vol. I (1973), Chapter 42 - Interior Wall and Ceiling Finish, Sections 4201-4203.

SUMMARY OF TEST RESULTS (Cont.)

B. Flame Resistance Permanency per ASTM C-739

The results reported are an average of three (3)

determinations per test.

Char Length, in.		Heat Generation, °F	
Orig. Cond.	Aged.	Orig. Cond.	Aged
3.6	3.9	185	190

Percent Change: 7.7   2.6

COMMENT:

The submitted sample falls within the 20% maximum

allowable change in char length after accelerated

aging indicating its flame resistance permanency.

ASTM E-84 DATA SHEET

CLIENT: Solar Energy Control, Inc. DATE: 4-12-77

MATERIAL: Loose-fill cellulose fiber insulation

THICKNESS: 2 inch MOISTURE LOSS: 0.09 kg

TEST MEASUREMENTS:

AIR: Rm. Temp. 73 °F GAS: Total Consumed 48.40 cf

R.H. 38 % Pressure, Static 2.0 "H_2O

TUNNEL: Brick Temp. 105 °F Kinetic 6.0 "H_2O

Air Velocity 240 fpm

Gauge 0.070 "H_2O

FLAME SPREAD:

Ignition 52 seconds

Flame Spread 2.0 (ft. max.) Time 10 minutes

Afterburning None

Calculation 5.128 X 2.0 = 10.26   0.564 X 17.7639 = 10.02

FLAME SPREAD by: Time/Distance Ratio Calculation	10
FLAME SPREAD by: Area under Time/Distance Curve	10
FUEL CONTRIBUTION:	0
SMOKE DENSITY:	0

POST TEST NOTATIONS

SAMPLE: Solar Energy Control, Inc.
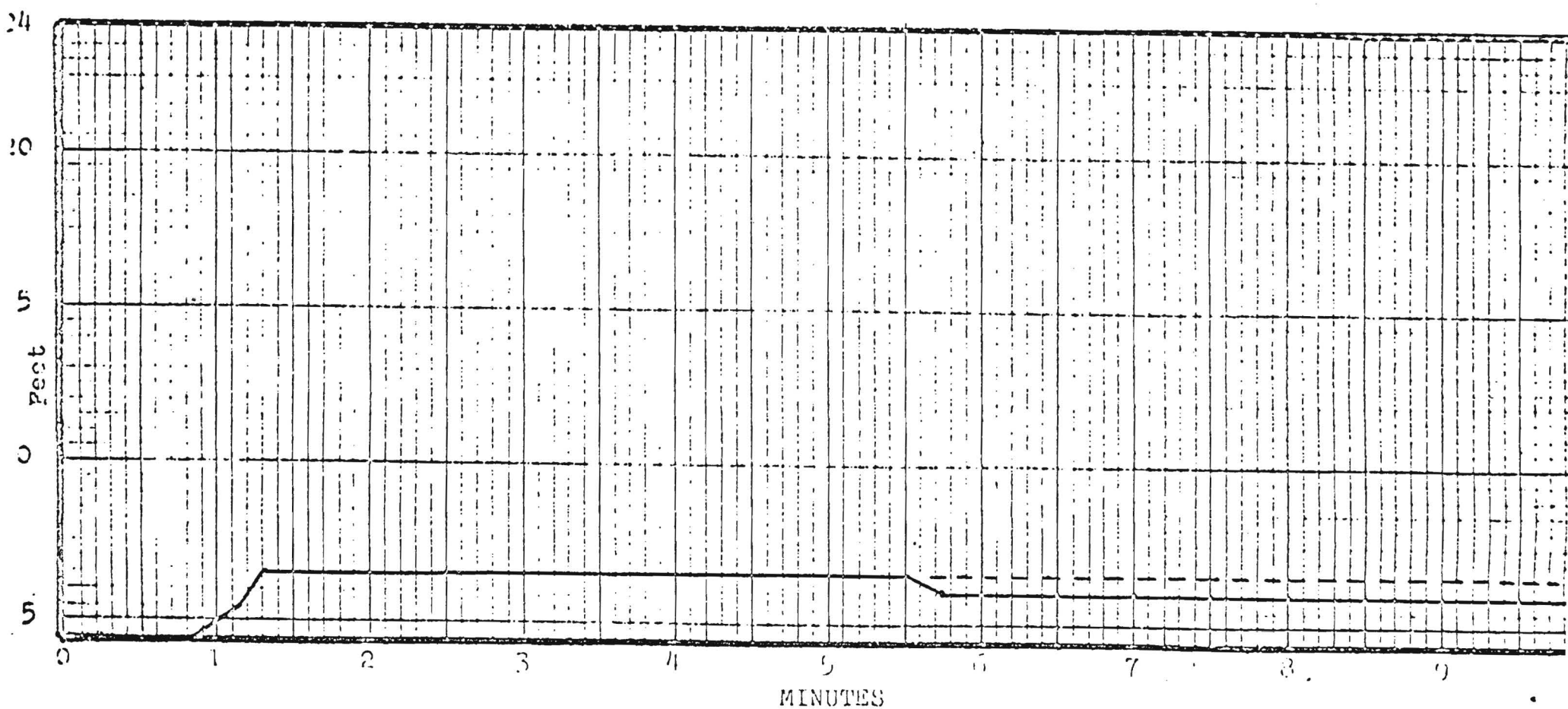
FLAME SPREAD

SMOKE DENSITY

KEY: Sample —o——o— Solar Energy Control, Inc

Loose-fill Cellulose Fiber Insulation

Red Oak —+——+—

Light Absorption (Millivolts) vs. Minutes
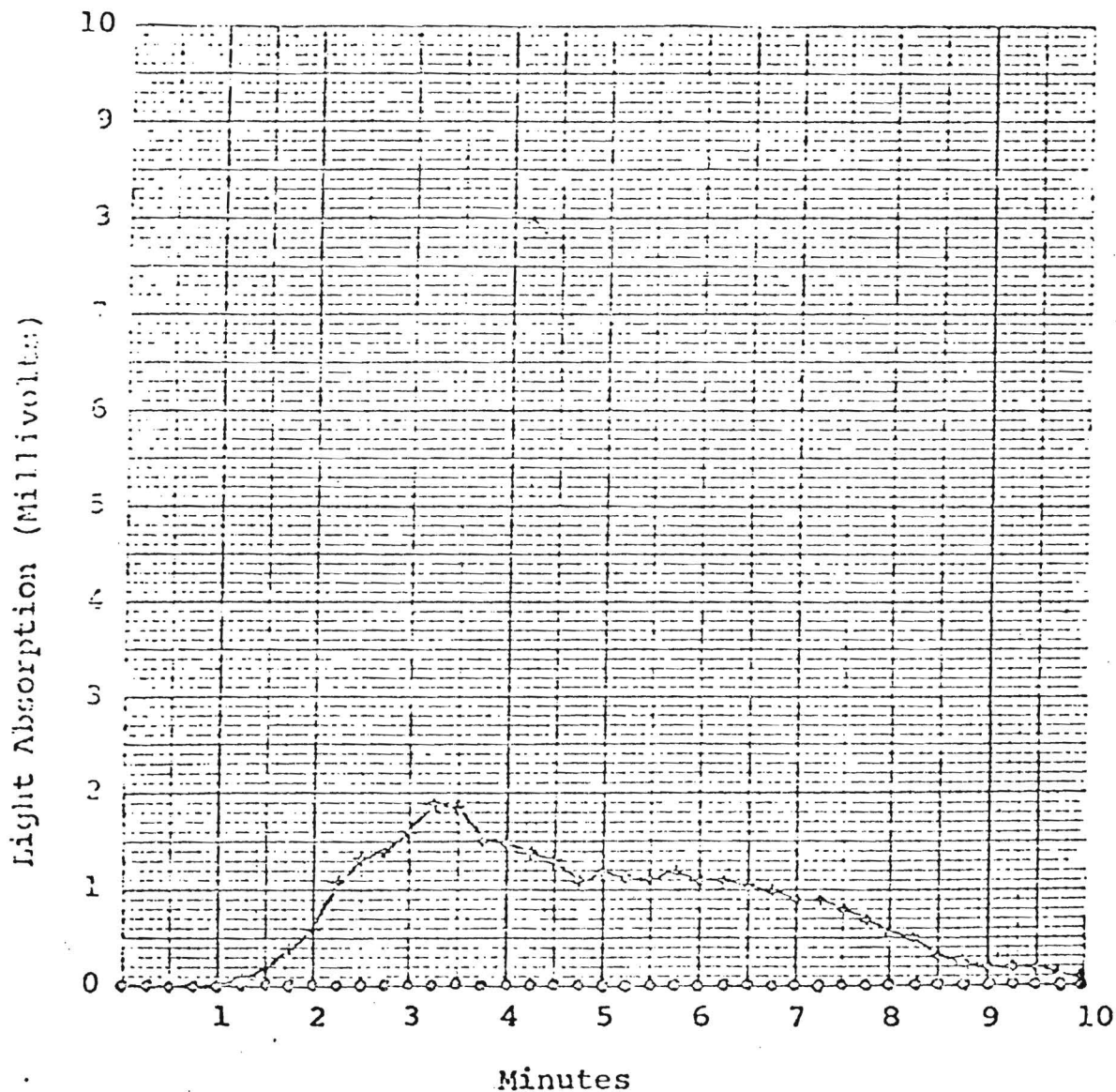
? Feb:350

FUEL CONTRIBUTED TEMPERATURE

Key:
Sample –o——o— Solar Energy Control, Inc.

Red Oak –+——+——+   Asbestos Cement Board –•——•——•—
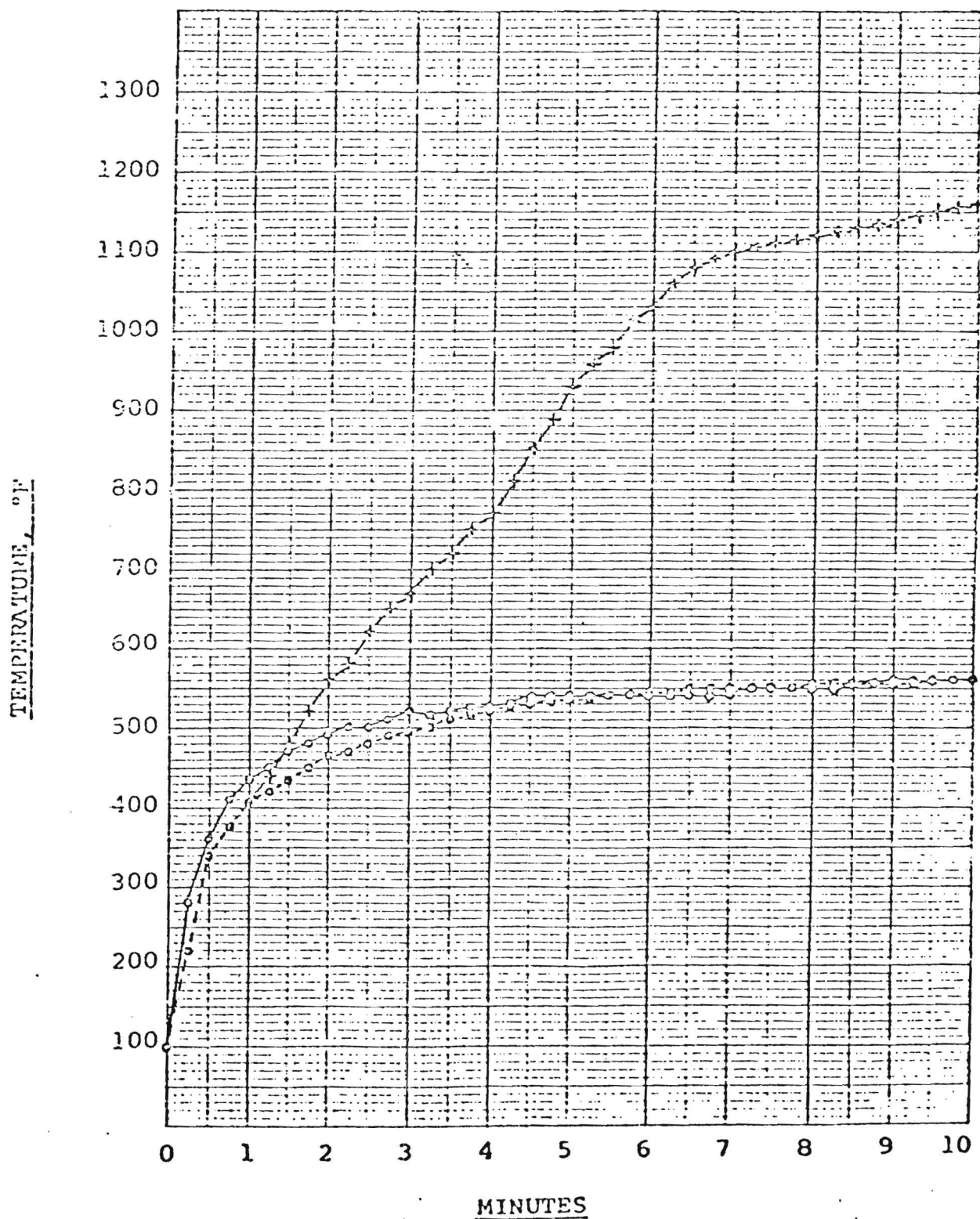
TEMPERATURE, °F

MINUTES

11

2 Feb. 1371 /2374

United States Testing Company, Inc.
California Division
5521 TELEGRAPH ROAD • LOS ANGELES, CALIFORNIA 90040 • 213—722-0608

REPORT OF TEST

CLIENT:
Solar Energy Control Company, Inc.
1017 Trotwood Drive
Lexington, Ky. 40511

SUBJECT: Evaluation of Loose Fill Cellulose Insulation.

REFERENCE:

Tests and charges authorized by Mr. Barry M. Ratliff and Mr. Jack Belcher.

Purchase Order Number 11928.

SAMPLE DESCRIPTION:

One (1) bag of loose fill cellulose insulation weighing approximately thirty (30) pounds was submitted by the Client.

REQUEST AND METHOD:

The cellulose insulation shall be subjected to the following tests per Federal Specification HH-I-515C and ASTM C-739-73 referenced therein:

1. Density per ASTM C 519 - Density of Fibrous Loose Fill Building Insulations.

2. Moisture Absorption.

3. Odor Emission.

4. Corrosiveness to Metals after exposure to 120°F and 96±3% relative humidity for seven (7) days.

SIGNED FOR THE COMPANY

BY

Tech.: W. Jackson

Victor Suben

Laboratories in: New York • Chicago • Los Angeles • Tulsa • Memphis • Reading • Richland

CLIENT:

Solar Energy Control Company, Inc.

Number
LA 70204

REQUEST AND METHOD:
    (cont.)

        5. Starch content per ASTM D 591 - Starch in Paper, using
            the qualitative procedure only.

RESULTS:

		HH-I-515C Specification
Density, lbs./cubic ft. (avg.)	2.8	3.0 maximum
Moisture Absorption, % (avg.)	14.5	15 maximum
Odor Emission (avg.)	No objectionable odor detected	No objectionable odor.
Corrosiveness to metals		
Bare aluminum	No corrosion	No corrosion of
Soft Copper	No corrosion	metal building
Cold Rolled Steel	No corrosion	materials.
Starch Content	None detected	Certification of chemical treatment if starch found present.

CONCLUSION:
The sample of cellulose insulation complies with the requirements
of Federal Specification HH-I-515C for Density, Moisture Absorp-
tion, Odor Emission, Corrosiveness, and Starch Content.

APPENDIX A—PROCEDURE FOR ANALYZING FIRE RETARDANT ADDITIVES

(1) Check sample for organic additives by extraction with suitable solvents. Check sample for ethanol solubles in particular.

(2) Oven dry a weighted sample at 80°C for one hour to determine moisture level "as received."

(3) If results of (1) through (3) are negigible, proceed with water extraction.

(4) Combine 5 grams of insulation sample with 100–200 ml distilled water in suitable container and warm on hot plate for 5 minutes. Stir occasionally.

(5) Remove water and dissolved material from wet cellulose by vacuum filtration. Retain washed cellulose on filter paper in buchner funnel.

(6) Set aside 100 ml of the filtrate for analysis.

(7) Wash cellulose with three 100 ml portions of hot distilled water and one 50 ml portion of 95 percent ethanol.

(8) Transfer cellulose to watch glass and dry one hour at 100°C.

(9) Weigh watch glass and cellulose. Place cellulose in labeled bottle, wipe dust from watch glass and weigh.

(10) Computer weight of dried cellulose and percent water solubles by difference.

(11) Heat filtrate retained in step (6) at 80–90°C until water has evaporated. Remove dried solids, grind and mix to assure uniformity. Place in labeled vial.

(12) Perform emission spectrographic and X-ray fluorescence analyses to detect elements.

(13) Confirm compounds and elements detected in steps (11) and (12) using X-ray diffraction and differential thermal analysis.

(14) Quantitatively determine metallic elements using atomic absorption spectrophotometry.

(15) Quantitatively determine metallic elements by using the quantity of that element present and the molecular weight of the most likely molecular form and hydration state.

(16) Quantitatively determine those compounds which do not contain metallic elements by subtracting known substances in those cases where all residue components are identifiable.

APPENDIX B—PROCEDURE FOR DETERMINING pH OF CELLULOSIC SAMPLES

(1) Allow a quantity of distilled water to equilibrate with atmospheric CO_2 (approximately pH 5.7).

(2) Add 50 ml of water to one gram insulation sample and stir for approximately five minutes using an electric stirrer.

(3) If the sample does not wet readily, add 0.1 ml of a 5 percent Trident Solution to the mixture prior to stirring. (This will not alter the final pH).

(4) Using a Beckman Zeromatic pH meter and Combination Electrode (Beckman Part No. 39013), determine the pH of the suspension.

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race St., Philadelphia, Pa. 19103
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If not listed in the current combined index, will appear in the next edition.

Standard Test Method for
SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS[1]

This Standard is issued under the fixed designation E 84; the number immediately following the designation indicates the year of original adoption, or in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 This method for surface burning characteristics of building materials is applicable to any type of building material that, by its own structural quality or the manner in which it is applied, is capable of supporting itself in position or may be supported in the test furnace to a thickness comparable to its recommended use.

1.2 The purpose of the test is to determine the comparative burning characteristics of the material under test by evaluating the flame spread over its surface when exposed to a test fire and to thus establish a basis on which surface burning characteristics of different materials may be compared, without specific considerations of all the end-use parameters that might affect the surface burning characteristics.

1.3 Smoke density as well as the flame-spread rate are recorded in this test. However, there is not necessarily a relationship among these measurements.

1.4 It is the intent of this method to register performance during the period of exposure, and not to determine suitability for use after the test exposure.

1.5 *This standard should be used to measure and describe the properties of materials, products, or systems in response to heat and flame under controlled laboratory conditions and should not be used for the description or appraisal of the fire hazard of materials, products, or systems under actual fire conditions.*[1]

Note 1 — The values stated in U S customary units are to be regarded as the standard.

2. Applicable Documents

2.1 *ASTM Standards:*

A 390 Specification for Zinc-Coated (Galvanized) Steel Poultry Netting (Hexagonal and Straight Line) and Woven Steel Poultry Fencing[3]

D 2016 Tests for Moisture Content of Wood[4]

3. Fire Test Chamber

3.1 The fire test chamber, Figs. 1 and 2, shall consist of a horizontal duct having an inside width of 17¾ ± ¼ in. (451 ± 6.3 mm) measured at ledge location along side walls and 17⅝ ± ⅜ in. (448 ± 10 mm) at all other points; a depth of 12 ± ½ in. (305 ± 13 mm) measured from the bottom of the test chamber to the ledge of the inner walls on which the specimen is supported (including the ⅛-in. (3.2-mm) thickness of asbestos fabric gasketing tape); and a length of 25 ft (7.62 m). The sides and base of the duct shall be lined with an insulating masonry material as illustrated in Fig. 2, consisting of A. P. Green, G-26[5] refractory fire brick. One side

shall be provided with double observation windows[a] with the inside pane flush mounted (See Fig. 2). Exposed inside glass shall be $2\frac{3}{4} \pm \frac{3}{4}$ by 11 plus 1, minus 2 in. $(70 \pm 10$ by 279 plus 25 minus 50 mm). The centerline of the exposed area of the inside glass shall be in the upper half of the furnace wall, with the upper edge not less than 2.5 in. (63 mm) below the furnace ledge. The window shall be located such that not less than 12 in. (305 mm) of the specimen width can be observed. Multiple windows shall be located along the tunnel so that the entire length of the test sample may be observed from outside the fire chamber. The windows shall be pressure tight as described by 5.2 and 5.2.1.

3.2 The ledges shall be fabricated of structural materials[2] capable of withstanding the abuse of continuous testing, level with respect to the length and width of the chamber and each other, and maintained in a state of repair commensurate with the frequency, volume, and severity of testing occurring at any time.

3.3 To provide air turbulence for proper combustion, turbulence baffling shall be provided by positioning six A. P. Green, G-26[3] refractory fire bricks (long dimension vertical, $4\frac{1}{2}$-in. (114-mm) dimension along the wall) along the side walls of the chamber at distances of 7, 12, and $20 \pm \frac{1}{2}$ ft (2.1, 3.7, and 6.1 ± 0.2 m) on the window side and $4\frac{1}{2}$, $9\frac{1}{2}$, and $16 \pm \frac{1}{2}$ ft (1.3, 2.9, and 4.9 ± 0.2 m) on the opposite side.

3.4 The top shall consist of a removable noncombustible (metal and mineral composite) structure, insulated with nominal 2 in. (51 mm) thick mineral composition material as shown in Fig. 2 and of a size necessary to cover completely the fire test chamber and the test samples. The lid shall be maintained in an unwarped and flat condition. The mineral composition material shall have physical characteristics comparable to the following:

Maximum effective temperature:	1200°F (649°C)
Bulk density	12.5 ± 1.5 lb/ft³ (199.1 ± 24.0 kg/m³)
Thermal conductivity at 300 to 700°F (149 to 371°C)	0.45 to 0.65 Btu·in./h·ft²·°F (0.78 to 1.13 W/m·K)

The entire lid assembly shall be protected with flat sections of high-density (nominal 110 lb/ft³ or 1761 kg/m³) $\frac{1}{4}$-in. (6.3-mm) asbestos-cement board, maintained in an un-

warped and uncracked condition through continued replacement. This protective board may or may not be secured to the furnace lid. When in place the top shall be completely sealed against the leakage of air into the fire test chamber during the test.

3.5 One end of the test chamber, designated as the "fire end," shall be provided with two gas burners delivering flames upward against the surface of the test sample. The burners shall be spaced 12 in. (305 mm) from the fire end of the test chamber, and $7\frac{1}{2} \pm \frac{1}{2}$ in. (190 ± 13 mm) below the under surface of the test sample. The air intake shutter shall be located 54 ± 5 in. (1372 ± 127 mm) upstream of the burner, as measured from the burner centerline to the outside surface of the shutter. Gas to the burners shall be provided through a single inlet pipe, distributed to each port burner through a tee-section. The outlet shall be a $\frac{1}{4}$-in. elbow. The plane of the port shall be parallel to the furnace floor, such that the gas is directed upward toward the specimen. Each port shall be positioned with its centerline $4 \pm \frac{1}{2}$ in. (102 ± 13 mm) on each side of the centerline of the furnace so that the flame is evenly distributed over the width of the exposed specimen surface (see Fig. 2). The controls used to assure constant flow of gas to the burners during period of use shall consist of a pressure regulator, a gas meter calibrated to read in increments of not more than 0.1 ft³ (2.8 litres), a manometer to indicate gas pressure in inches of water, a quick-acting gas shut-off valve, a gas metering valve, and an orifice plate in combination with a water manometer to assist in maintaining uniform gas flow conditions. An air intake fitted with a vertically sliding shutter extending the entire width of the test chamber shall be provided at the fire end. The shutter shall be positioned so as to provide an air inlet port $3 \pm \frac{1}{16}$ in. (76 ± 2 mm) high measured from the floor level of the test chamber at the air intake point.

3.6 The other end of the test chamber, designated as the "vent end," shall be fitted

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[a] Heat-resistant glass Vycor, 100 % silica glass, nominal $\frac{1}{4}$ in. thick, has been found suitable for the interior pane. Pyrex glass, nominal $\frac{1}{4}$ in. thick, has been found suitable for the exterior pane.

[2] High-temperature furnace refractory Zircoa has been found suitable for this purpose.

with a gradual rectangular-to-round transition piece, not less than 20 in. (508 mm) in length, with a cross-sectional area of not less than 200 in.² (1290 cm²) at any point. The transition piece shall in turn be fitted to a 16-in. (406-mm) diameter flue pipe. The movement of air shall be by an induced draft system having a total draft capacity of at least 0.15-in. (3.8-mm) water column with the sample in place, the shutter at the fire end open the normal 3 ± 1/16 in. (76 ± 2 mm), and the damper in the wide open position. A draft gage to indicate static pressure shall be joined with the vent pipe using a surface mount connection upstream of the damper and photoelectric cell opening and at a point of minimum air turbulence, at least 16 diameters (approximately 21 ft (6.4 m)) from the vent end of the chamber.

3.7 A light source³ shall be mounted on a horizontal section of the 16-in. (406-mm) diameter vent pipe at a point where it will be preceded by a straight run of pipe (at least 12 diameters or 16 ft (4.88 m) and not more than 30 diameters (40 ft (12.19 m)) from the vent end of the chamber, and with the light beam directed upward along the vertical axis of the vent pipe. The vent pipe shall be insulated with at least 2 in. (51 mm) of high-temperature mineral composition material, from the vent end of the chamber to the photometer location. A photoelectric cell³ of which the output is directly proportional to the amount of light received shall be mounted over the light source and connected to a recording device having a minimum operating chart width of 5 in. (127 mm) with an accuracy within ±1 % of full scale, for indicating changes in the attenuation of incident light by the passing smoke, particulate, and other effluent. The distance between the light source lens and the photocell lens shall be 36 ± 4 in. (914 ± 102 mm). The cylindrical light beam shall pass through 3-in. (76-mm) diameter openings at the top and bottom of the 16-in. diameter duct, with the resultant light beam centered on the photocell.

3.8 Linearity of the photometer system shall be verified periodically by interrupting the light beam with calibrated neutral density filters. The filters shall cover the full range of the recording instrument. Transmittance values measured by the photometer, using neu-

tral density filters, shall be within ±3 % of the calibrated value for each filter.

3.9 An automatically controlled damper to regulate the draft pressure shall be installed in the vent pipe down-stream of the smoke-indicating attachment. The damper shall be provided with a manual override.

3.10 Other manual or automatic draft regulation devices or both may be incorporated to maintain fan characterization and air-flow control throughout test periods.

3.11 A No. 18 Awg (1.02-mm) thermocouple, with 3/8 ± 1/8 in. (9.5 ± 3.2 mm) of the junction exposed in the air, shall be inserted through the floor of the test chamber so that the tip is 1 ± 1/32 in. (25.4 ± 0.8 mm) below the top surface of the asbestos gasketing tape and 23 ft ± 1/2 in. (7.0 m ± 13 mm) from the centerline of the burner ports at the center of its width.

3.12 A No. 18 Awg (1.02-mm) thermocouple embedded 1/8 in. (3.2 mm) below the floor surface of the test chamber shall be mounted in refractory or portland cement, carefully dried to avoid cracking, at distances of 13 ft ± 1/2 in. (3.96 m ± 13 mm) and 23 1/4 ft ± 1/2 in. (7.09 m ± 13 mm) from the centerline of the burner ports.

3.13 The room in which the test chamber is located shall have provision for a free inflow of air during the test to maintain the room at atmospheric pressure during the entire test run.

4. Test Specimens

4.1 The test specimen shall be at least 2 in. (51 mm) wider (nominally 20 1/4 ± 1/4 in. (514 ± 19 mm)) than the interior width of the tunnel and total 24 ft ± 1/2 in. (7.32 m ± 13 mm) in length. The specimen may consist of a continuous, unbroken length, or of sections joined end-to-end. A 14 ± 1/8-in. (356 ± 3-mm) length of uncoated 16-gage (0.053 to 0.060 in.) steel sheet shall be placed on specimen mounting ledge in front of and under the specimen in the upstream end of the tunnel. Specimens shall be truly representative of the materials for which test results are desired. Properties adequate for identifi-

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³ A Weston Instruments No. 85528 Photocell cell and 12-V sealed beam, clear lens, auto spot lamp, with an overall bulb-to-cell path length of 36 ± 4 in. (914 ± 102 cm) has been found suitable for this purpose.

cation of the materials or ingredients, or both, of which the test specimen is made shall be recorded.

4.2 The test specimen shall be conditioned to a constant weight at a temperature of 73.4 ± 5°F (23 ± 2.8°C) and at a relative humidity of 50 ± 5 %.

5. Calibration of Test Equipment

5.1 Place a ¼-in. (6.3-mm) asbestos-cement board on the ledge of the furnace chamber, then place the removable lid of the test chamber in position.

5.2 With the ¼-in. (6.3-mm) asbestos-cement board in position on top of the ledge of the furnace chamber and with the removable lid in place, establish a draft to produce a 0.15-in. (3.8-mm) water-column reading on the draft manometer, with the fire-end shutter open 3 ± 1/16 in. (76 ± 1.6 mm), by manually setting the damper as a characterization of fan performance. Then close and seal the fire-end shutter, without changing the damper position. The manometer reading shall increase to at least 0.375 in. (9.53 mm), indicating that no excessive air leakage exists.

5.2.1 In addition, conduct a supplemental leakage test periodically with the fire shutter and exhaust duct beyond the differential manometer tube sealed, by placing a smoke bomb in the chamber. Ignite the bomb and pressurize the chamber to 0.375 ± 0.125 in. (9.53 ± 3.18 mm) water column. Seal all points of leakage observed in the form of escaping smoke particles.

5.3 Establish a draft reading within the range 0.055 to 0.085 in. (1.40 to 2.16 mm) water column. The required draft gage reading will be maintained throughout the test by the automatically controlled damper. Record the air velocity at seven points, 23 ft from the centerline of the burner ports, 6 ± ¼ in. (168 ± 7 mm) below the plane of the specimen mounting ledge. Determine these seven points by dividing the width of the tunnel into seven equal sections and recording the velocity at the geometrical center of each section. During the measurement of velocity, remove the turbulence bricks (see 3.3) and exposed 23-ft thermocouple and place 24-in. (670-mm) long straightening vanes between 16 and 18 ft (4.88 and 5.49 m) from the burner. The straightening vanes shall divide

the furnace cross section into nine uniform sections. Determine the velocity with furnace air temperature at 73.4 ± 5°F (23 ± 2.8°C), using a velocity transducer.[a] The velocity, determined as the arithmetic average of the seven readings, shall be 240 ± 5 ft (7.32 ± 1.5 m)/min.

5.4 Maintain the air supply at a temperature of 73.4 ± 5°F (23 ± 2.8°C), and a relative humidity of 50 ± 5 %.

5.5 Supply the fire test chamber with natural (city) or methane (bottled) gas fuel of uniform quality with a heating value of nominally 1000 Btu/ft³ (37.3 MJ/m³). Adjust the gas supply initially at approximately 5000 Btu (5.3 MJ)/min. Record the gas pressure, the pressure differential across the orifice plate, and the volume of gas used in each test. Unless otherwise corrected for, when bottled methane is employed, insert a length of coiled copper tubing into the gas line between the supply and metering connection to compensate for possible errors in the flow indicated due to reductions in gas temperature associated with the pressure drop and expansion across the regulator. With the draft and gas supply adjusted as indicated in 5.3 and 5.4, the test flame shall extend downstream to a distance of 4½ ft (1.37 m) over the specimen surface, with negligible upstream coverage.

5.6 Preheat the test chamber with the ¼-in. (6.3-mm) asbestos-cement board and the removable lid in place and with the fuel supply adjusted to the required flow. Continue the preheating until the temperature indicated by the floor thermocouple at 23¼ ft (7.09 m) reaches 150 ± 5°F (66 ± 2.8°C). During the preheat test, record the temperatures indicated by the thermocouple at the vent end of the test chamber at intervals not longer than 15 s and compare these readings to the preheat temperature shown in the time-temperature curve in Fig. 3. This preheating is for the purpose of establishing the conditions that will exist following successive tests and for indicating the control of the heat input into the test chamber. If appreciable variation from the temperatures shown in the representative preheat curve is observed,

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[a] A Thermo Systems Inc. Model 1610 velocity transducer (thermal anemometer) using a readout device accurate to 0.001 V, has been found workable for the purpose

suitable adjustments in the fuel supply may be necessary based on red oak calibration tests.

5.7 Allow the furnace to cool after each test. When the floor thermocouple at 13 ft (3.96 m) shows a temperature of 105 ± 5°F (40.5 ± 2.8°C), place the next specimen in position for test.

5.8 With the test equipment adjusted and conditioned as described in 5.2, 5.3, 5.4, and 5.6, make a test or series of tests, using nominal ¾-in. (18.3-mm) select-grade red oak flooring as a sample, conditioned to 6 to 8 % moisture content as determined by the 221°F (105°C) oven-dry method described in Methods D 2016. Make observations at distance intervals not in excess of 2 ft (0.6 m) and time intervals not in excess of 30 s, and record the time when the flame reaches the end of the specimen, that is, 19½ ft (5.94 m) from the end of the ignition fire. The end of the ignition fire shall be considered as being 4½ ft (1.37 m) from the burners. The flame shall reach the end point in 5½ min ± 15 s. Automatically record the temperatures measured by the thermocouple near the vent end at least every 15 s. Automatically record the photoelectric cell output immediately prior to the test and at least every 15 s during the test.

NOTE 2 — The flame may be judged to have reached the end point when the vent-end thermocouple registers a temperature of 980°F (527°C).

5.9 Plot the flame spread distance, temperature, and change in photoelectric cell readings separately on suitable coordinate paper. Figures 4, 5, and 6 are representative curves for red oak flame spread distance, time-temperature development, and smoke density, respectively. Flame spread distance shall be determined as the observed distance minus 4½ ft (1.37 m).

5.10 Following the calibration tests for red oak, conduct a similar test or tests on samples of ¼-in. (6.3-mm) asbestos-cement board. These results shall be considered as representing a classification of 0. Plot the temperature readings separately on suitable coordinate paper. Figure 7 is a representative curve for time-temperature development for asbestos-cement board.

6. Procedure

6.1 With the furnace draft operating, place the test specimen on the test chamber ledges which have been completely covered with nominal ⅛-in. (3.2-mm) thick by 1¼-in. (32-mm) wide woven asbestos tape. Place the specimen as quickly as is practical. Place the removable top in position over the specimen.

6.2 The completely mounted specimen shall remain in position in the chamber with the furnace draft operating for 120 ± 15 s prior to the application of the test flame.

6.3 Ignite the burner gas. Observe and record the distance and time of maximum flame front travel with the room darkened. Continue the test for a 10-min period. The test may be terminated prior to 10 min if the specimen is completely consumed in the fire area and no further progressive burning is evident and the photoelectric cell reading has returned to the baseline.

6.4 Record the photoelectric cell output immediately prior to the test and at least every 15 s during the test.

6.5 Record the gas pressure, the pressure differential across the orifice plate, and the volume of gas used in each test.

6.6 When the test is ended, shut off the gas supply, observe smoldering and other conditions within the test duct, and remove the specimen for further examination.

6.7 Plot the flame spread distance, temperature, and change in photoelectric cell readings separately on the same type of coordinate paper as used in 5.9 for use in determining the flame-spread and smoke-developed classifications as outlined in Section 7. The flame spread observations must be recorded at distance intervals not in excess of 2 ft (0.6 m) or time intervals not in excess of 30 s. In addition, the peak must be noted with the time of occurrence. Flame spread distance shall be determined as the observed distance minus 4½ ft (1.37 m).

7. Classification

7.1 The flame spread classification (FSC) shall be determined as follows:

7.1.1 The total area (A_T) under the flame spread time-distance curve shall be determined by ignoring any flame front recession. For example, in Fig. 8 the flame spread 10 ft (3.05 m) in 2½ min and then recedes. The area is calculated as if the flame had spread to 10 ft in 2½ min and then remained at 10

ft for the remainder of the test or until the flame front again passed 10 ft. This is shown by the dashed line in Fig. 8. The area (A_T) used for calculating the flame spread classification is the sum of areas A_1 and A_2 in Fig. 8.

7.1.2 If this total area (A_T) is less than or equal to 97.5 min·ft, the flame spread classification shall be 0.564 times the total area (FSC = 0.564 A_T).

7.1.3 If the total area (A_T) is greater than 97.5 min·ft, the flame spread classification shall be 5363, divided by the difference of 195 minus the total area (A_T). (FSC = 5363/(195-A_T)).

7.2 The test results for smoke shall be plotted, using the same coordinates as in 5.9. The area under the curve shall be divided by the area under the curve for red oak, and multiplied by 100, to establish a numerical classification by which the performance of the material may be compared with that of asbestos-cement board and select-grade red oak flooring, which have been arbitrarily established as 0 and 100, respectively.

Note 3 — Allowance should be made for accumulation of soot and dust on the photoelectric cell during the test by establishing a revised base line. The revised base line shall be a straight line drawn from the zero point (point on base line where incipient light attenuation occurs) to the point established after the sample has been removed.

8. Analysis of Products of Combustion

8.1 Although not required as a part of this method, products of combustion may be drawn from the test duct during the progress of the test for chemical analysis.
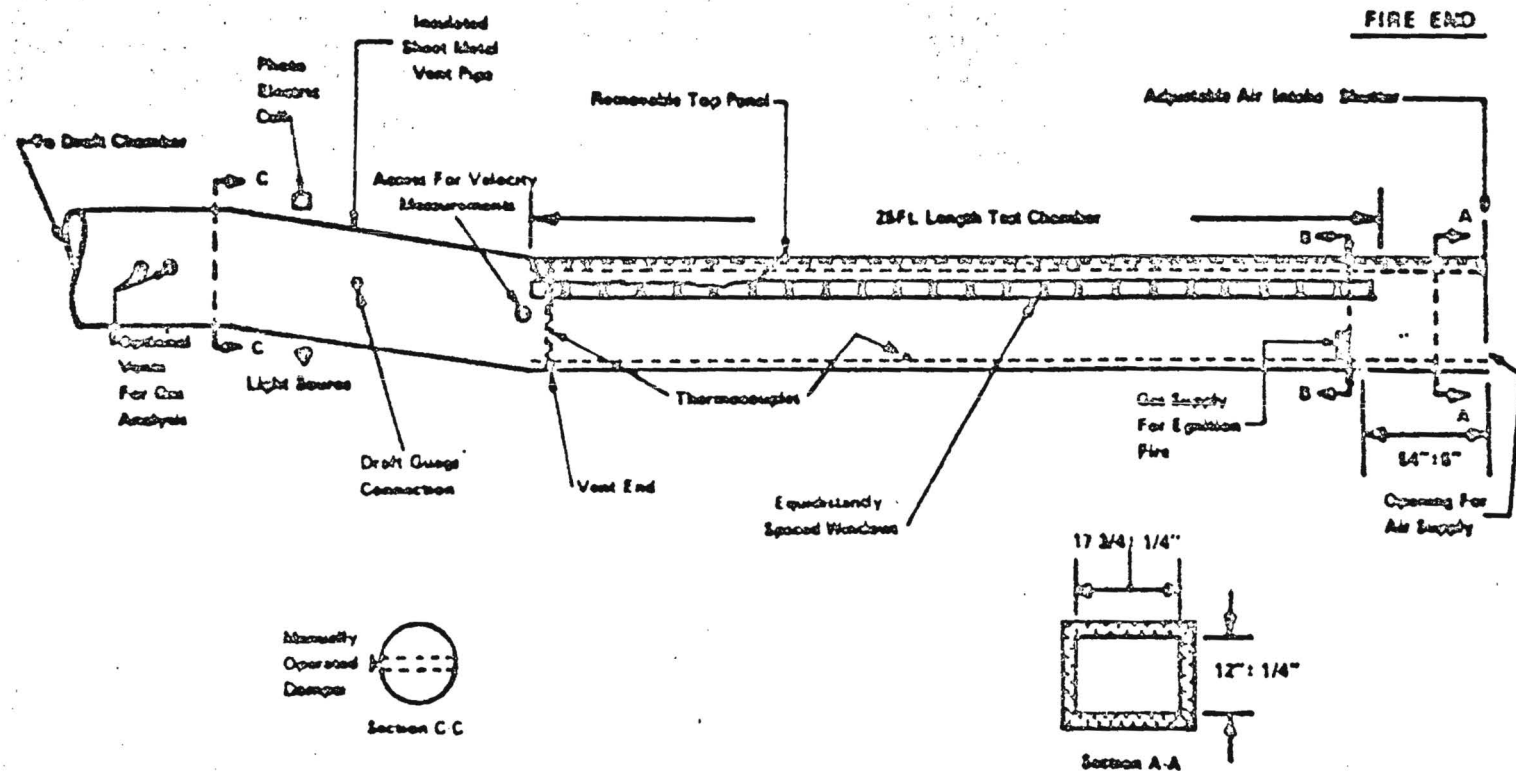
9. Report

9.1 The report shall include the following:

9.1.1 Description of the material being tested,

9.1.2 Test results as calculated in Section 7,

9.1.3 Details of the method used in placing the specimen in the test chamber, and

9.1.4 Observations of the burning characteristics of the specimen during test exposure, such as delamination, sagging, shrinkage, fallout, etc.

FIRE END

Insulated
Sheet Metal
Vent Pipe

Photo
Electric
Cell

Removable Top Panel

Adjustable Air Intake Shutter

Go Draft Chamber

C

Access For Velocity
Measurements

25 Ft Length Test Chamber

B

A

Optional
Vents
For Gas
Analysis

C

Light Source

Thermocouples

Gas Supply
For Ignition
Fire

B

A

Draft Gauge
Connection

Vent End

Equidistantly
Spaced Windows

54" : 5"

Opening For
Air Supply

17 3/4 : 1/4"

Manually
Operated
Damper

12" : 1/4"

Section C C

Section A-A

U. S. Customary Units

12 ± 1/4 in.
17 1/4 ± 1/4 in.
54 ± 5 in.
25 ft

Metric Equivalents

305 ± 6.3 mm
451 ± 6.3 mm
1371 ± 127 mm
7.62 m

FIG. 1 Test Furnace, Showing Some Critical Dimensions.

A-1

FIG. 3 Test Furnace Showing Some Critical Dimensions (Section "B-B" is not a Construction Drawing).
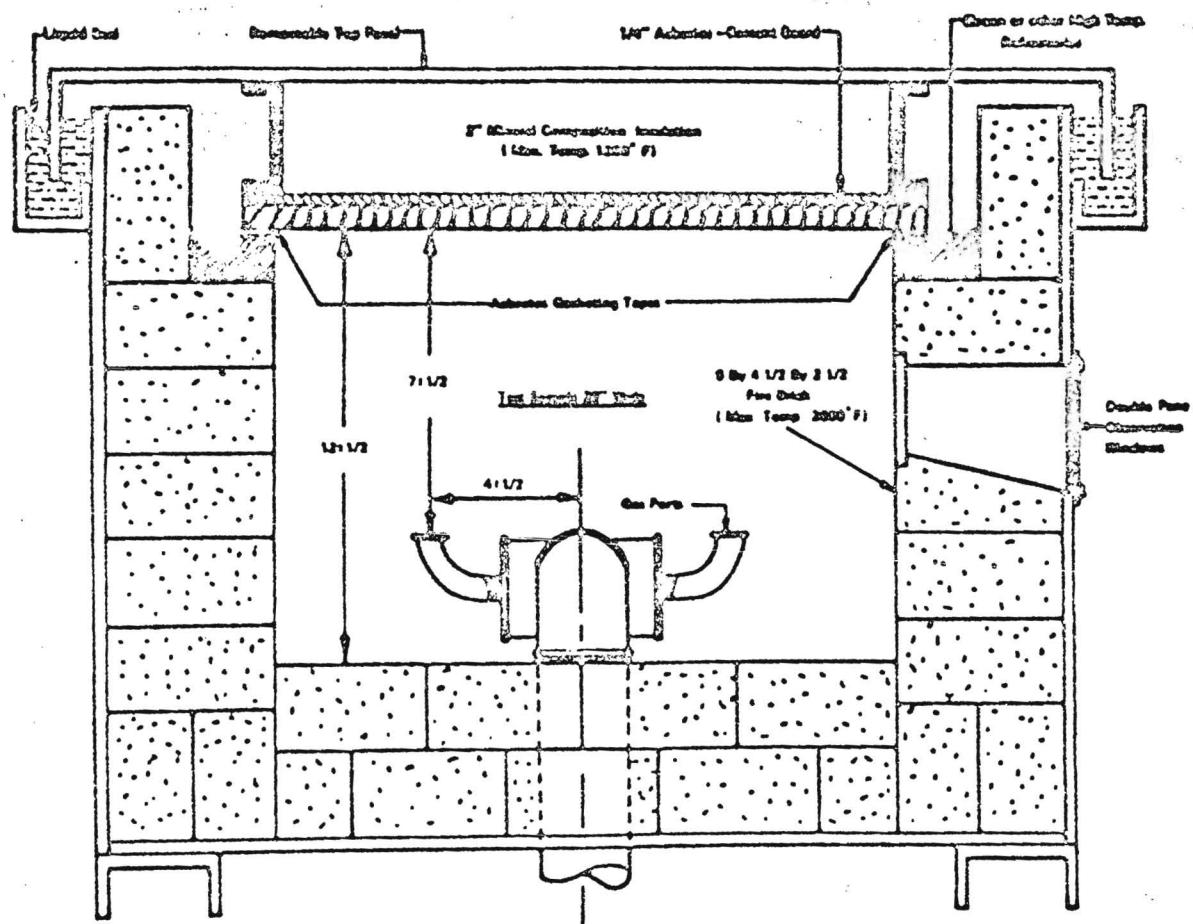
U. S. Customary Units	Metric Equivalents	U. S. Customary Units	Metric Equivalents
1/4 in.	6.3 mm	20 in.	508 mm
2 in.	51 mm	9 by 4 1/2 by 2 1/2 in.	230 by 115 by 65 mm
4 x 1/2 in.	102 x 13 mm	1200°F	649°C
7 x 1/2 in.	178 x 13 mm	2600°F	1427°C
12 x 1/2 in.	305 x 13 mm		
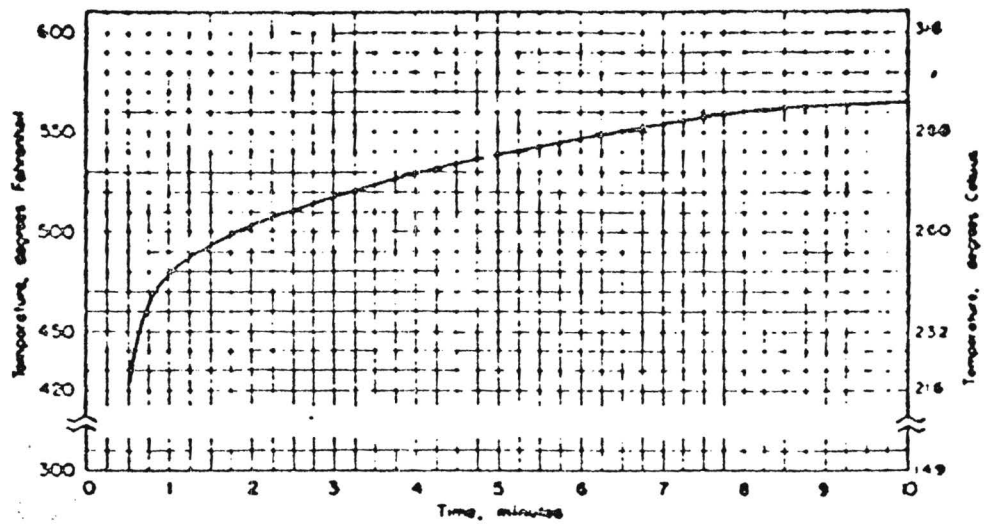
FIG. 3 Time-Temperature Curve for Preheat Temperature.

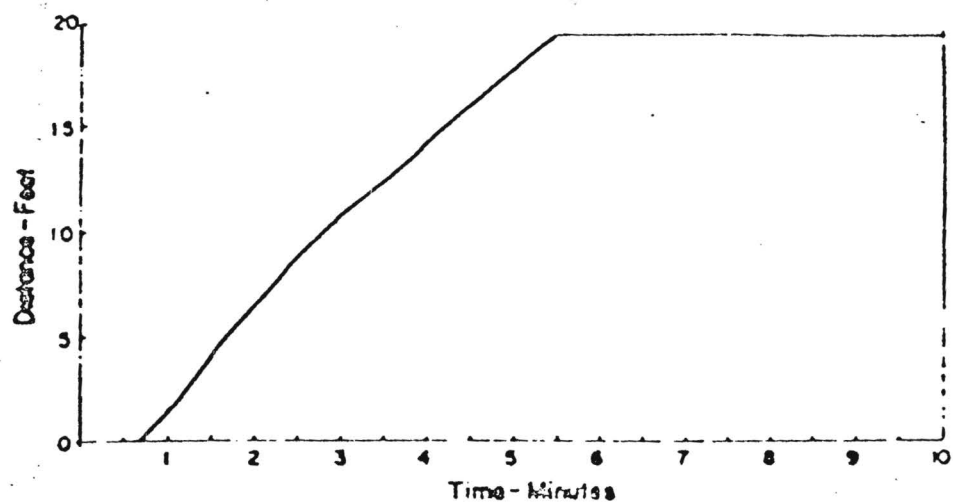FIG. 4 Time-Distance Curve for Flame Spread of Red Oak.
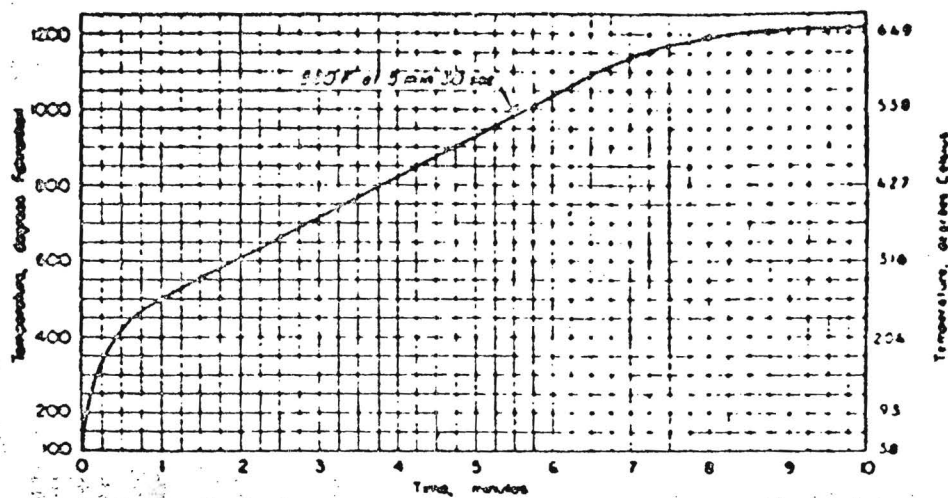
FIG. 5   Time-Temperature Curve for Fuel Contribution of Red Oak.
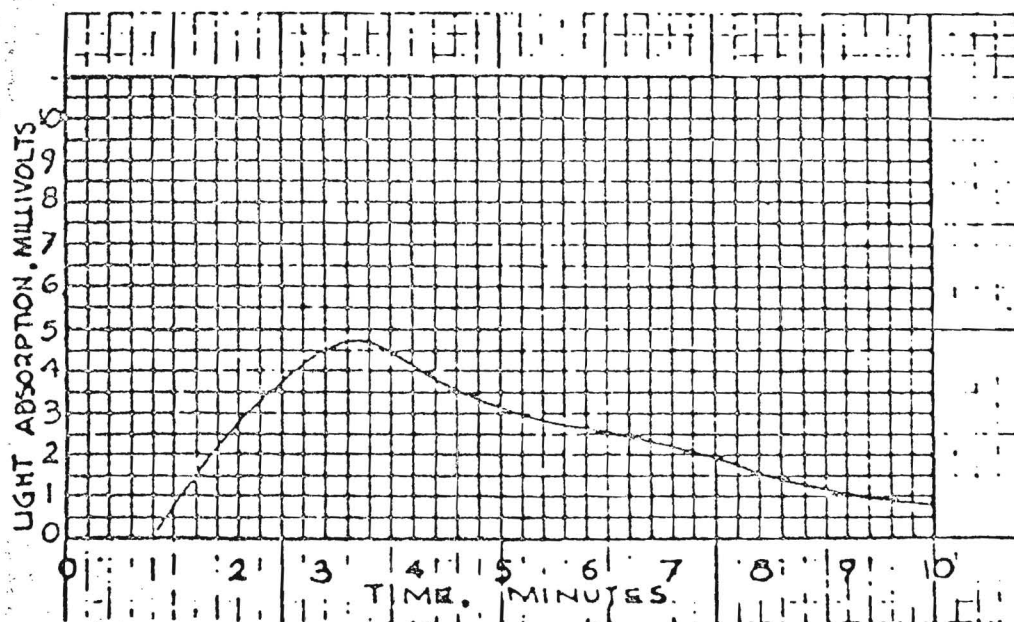

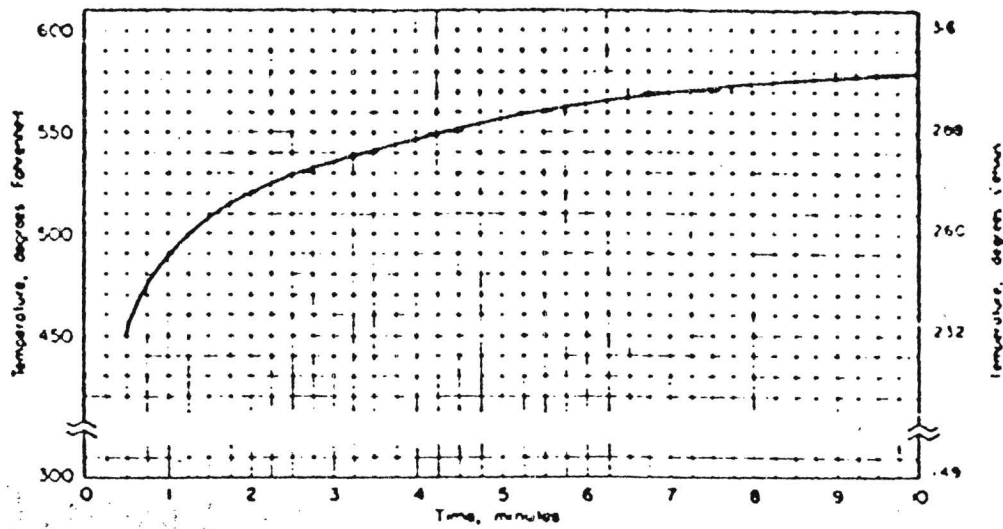FIG. 6   Time-Absorption Curve for Smoke Density of Red Oak.

FIG. 7 Time-Temperature Curve for Fuel Contribution of Asbestos-Cement Board.
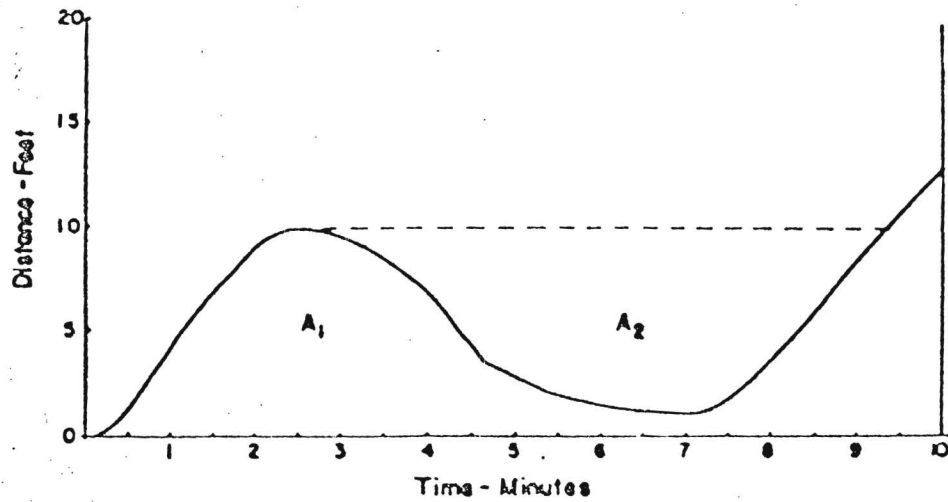

FIG. 8 Example of Time-Distance Curve with Flame Front Recession.

APPENDIXES

X1. GUIDE TO MOUNTING METHODS

X1.1 Introduction

X1.1.1 This guide has been compiled as an aid in selecting a method for mounting various building materials in the fire test chamber. These mountings are suggested for test method uniformity and convenience; they are not meant to imply restriction in the specific details of field installation.

X1.1.2 For some building materials none of the methods described may be applicable. In such cases, other means of support may have to be devised.

X1.1.3 These suggested mounting methods are grouped according to building materials to be tested which are broadly described either by usage or by form of the material.

X1.1.4 Whenever asbestos-cement board is specified as a backing in subsequent paragraphs, the material shall be nominal ¼ in. (6.3 mm) thick, high density (110 ± 5 lb/ft² (1762 ± 80 kg/m³)) and uncoated. When metal rods are specified as supports, ¼-in. (6.3-mm) metal rods spanning the width of the tunnel shall be used. Rods should be placed approximately 2 in (51 mm) from each end of each panel and additional rods shall be placed approximately at 2-ft (0.6-m) intervals starting with the first rod at the fire end of each panel.

X1.2 Acoustical and Other Similar Panel Products Less Than 20 in.

X1.2.1 For acoustical materials and other similar panel products whose maximum dimension is less than 20 in. (508 mm), metal splines or wood furring strips and metal fasteners shall be used.

X1.2.2 Steel tee splines for mounting kerfed-acoustical tile shall be nominal ½ in. (13-mm) web by ¾-in. (19-mm) flange, formed No. 24 MS gage sheet metal.

X1.2.3 Wood furring frames for mounting acoustical materials and other similar panel products less than 20 in. (508 mm) shall be nominal 2 by 2-in. (20 by 41-mm) wood furring joined with corrugated-metal fasteners. Use two frames as shown in Fig. X1.1.

X1.3 Adhesives

X1.3.1 To determine the surface burning characteristics of adhesives, they shall be mixed as specified in the manufacturer's instructions and shall be applied to asbestos-cement board in the thickness or at the coverage rate recommended by the manufacturer. The adhesive application shall be cured prior to testing.

X1.4 Batt or Blanket-Type Insulating Materials

X1.4.1 Batt or blanket materials that do not have sufficient rigidity or strength to support themselves shall be supported by metal rods inserted through the material and positioned such that the bottom of the rod is approximately ¼ in. (6.3 mm) from the surface to be exposed to the flame. It is recommended that batt or blanket materials less than 1 in. (25.4 mm) thick not be mounted for testing in this manner.

X1.5 Coating Materials, Cementitious Mixtures, and Sprayed Fibers

X1.5.1 Coating materials, cementitious mixtures, and sprayed fibers shall be mixed and applied to the substrate as specified in the manufacturer's instructions at the thickness, coverage rate, or density recommended by the manufacturer.

X1.5.2 Materials intended for application to wood surfaces shall be applied to a substrate made of 1 by 4-in. (20 by 92-mm) nominal "C" and better VG Douglas fir flooring (FSC 70 to 90) or to other species for which the surface burning characteristic is to be measured. Paragraph 104-C of Issue 16 of Standard Grading Rules for West Coast Lumber, published by the West Coast Inspection Bureau, shall apply in identifying the Douglas fir flooring. The pieces shall be placed side by side and secured with four nailing strips spaced approximately 3½ ft (1.07 m) apart holding the pieces together (see Fig. X1.2). Two decks placed end to end shall be used.

X1.5.3 Materials intended for application to particular combustible surfaces, but not wood, shall be applied to the specific surfaces for which they are intended.

X1.5.4 Materials intended for only field application to noncombustible surfaces shall be applied to ¼-in. (6.3-mm) asbestos-cement board.

X1.6 Loose-Fill Insulation

X1.6.1 Loose-fill insulation shall be placed on galvanized-steel screening with approximate ½-in. (12-mm) openings supported on a test frame 20 in. (508 mm) wide by 2 in. (51 mm) deep made from 2 by 3 by ¼-in. (51 by 76 by 5 mm) steel angles. Three frames are required. See Fig. X1.3. The insulation shall be packed to the density specified by the manufacturer.

X1.7 Plastics

X1.7.1 The term plastics includes foams, reinforced panels, laminates, grids, and transparent or translucent sheets.

X1.7.2 When any plastic will remain in position in the tunnel during a fire test, no additional support will be required. Thermoplastic materials and other plastics which will not remain in place are to be supported by ¼-in. (6.3-mm) round-metal rods, or ⅛ by 2-in. (5 by 51-mm) wide steel bars or 2-in galvanized hexagonal wire-mesh supported with metal bars or rods spanning the width of the tunnel.

X1.8 Thin Membranes

X1.8.1 Single-layer membranes or thin laminates consisting of a limited number of similar or dissimilar layers may be supported on poultry netting placed on metal rods as provided in X1.1.4. Netting shall be 20-gage, 2-in. (51-mm) hexagonal galvanized steel poultry netting conforming to Specification A 390. If so tested, the specimen shall be additionally tested, bonded to a substrate representative of a field installation.

X1.9 Wall Coverings

X1.9.1 Wall coverings of various types shall be mounted to ¼-in. (6.3-mm) asbestos-cement board with the adhesive specified by the manufacturer in a manner consistent with field practice.

Nominal 1"x 2"(28 x 41cm)   Corrugated fasteners all joints
Wood furring strips

12"
83 m

20"
83 m

4'-2" — 1.77m   4'-2" — 1.77m

12'-5-1/2" — 3.89 m

2 Required
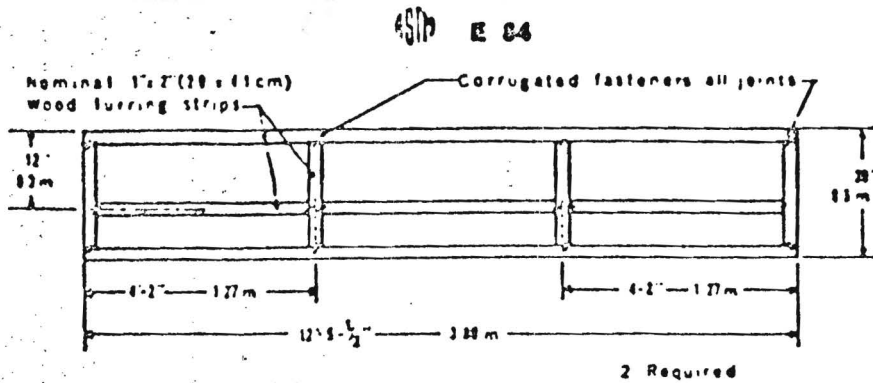
FIG. X1.1 Wood Frame for Acoustical Materials and Other Similar Panel Products Less Than 20 in. (508 mm).

Nominal 1"x6" (28 x 92 cm)
T & G Douglas Fir lumber   Staple or nail
Each board, full length   12 per batten

20"
83 m

12" — 3-6" — 1.87m   3-6" — 1.87m — 12"
83m   83m

12'-5-1/2" — 3.88 m

2 Required
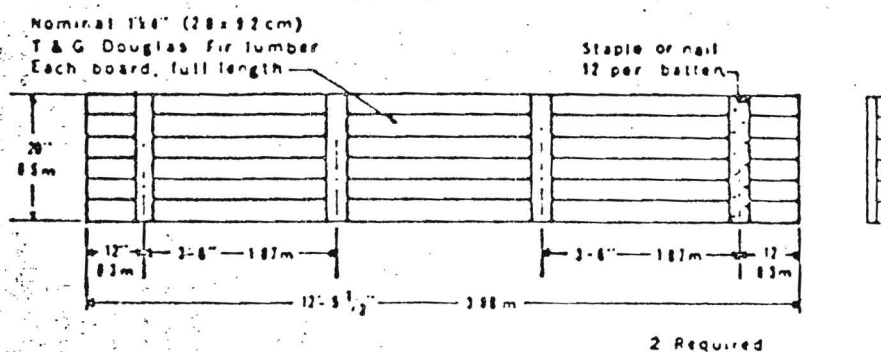
FIG. X1.2 Wood Deck for Coating Material.

3"x3"x 2/16" Steel Angles   1-1/2" x 19-1/2 x 3/16" Steel Cars
78 x 3.1 x 8.3 cm   38 x 48.3 x 8.3 cm

20"
83 m

Screening

4'-1-3/4" — 1.28 m   4'-1-3/4" — 1.28 m

3" (76 cm)

2" (5.1 cm)

8'-3-1/2" — 3.12 m

3 Required

FIG. X1.3 Steel Frame for Loose Fill Materials.

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A-13

X2. DERIVATION OF FLAME SPREAD AREA FORMULAS APPEARING IN 7.1

X2.1 Introduction

X2.1.1 This appendix contains an abbreviated discussion of the derivations of the flame spread area formulas used to calculate the flame spread value in this test method. This appendix will show not only the derivations of the formulas, but will illustrate the relationship between this method of flame spread calculation and a previous method.

X2.1.2 In these calculations, it is assumed that the flame front never recedes. Hence, in Fig. 8 there is an imaginary line bounding the upper edge of area A_p.

X2.2 Formula 1

X2.2.1 For total areas less than or equal to 97.5 min·ft, calculate the flame spread as follows:

$$FSC = 0.564\, A_T$$

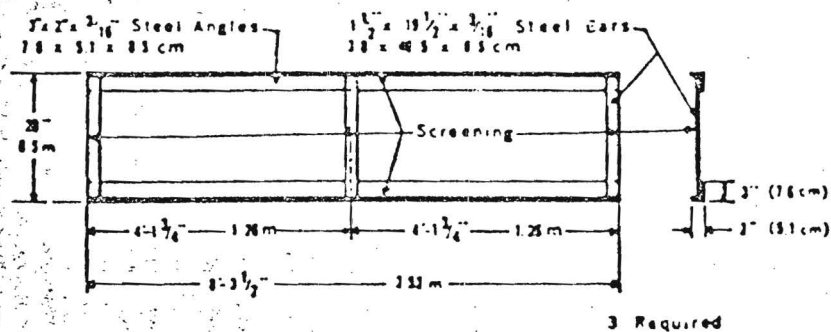X2.2.1.1 In Fig. X2.1, an idealized straight-line flame spread distance-time plot is drawn. Lines OA, OA', and OA'' produce a family of areas ORA having a maximum possible area of 97.5 min·ft ($\frac{1}{2}$ by 10 min by 19.5 ft). These represent a steady progression of the flame front to a maximum distance at the end of the 10-min test

X2.2.1.2 When the flame front spreads its maximum distance (19.5 ft) in 10 min, a formula used in Method E 84 would yield the following.

$$FSC = \frac{550}{t} = \frac{550}{10} = 55$$

X2.2.1.3 Also, when the flame front is maximized at 19.5 ft in 10 min, the area in Fig. X2.1 ORA is maximized to 97.5 min·ft.

X2.2.1.4 To relate the current formula, which is of the straight line, origin intercept form, to the previous (Method E 84) formula, it is necessary to equate the two as follows.

$$FSC = \frac{550}{t} = K A$$

where
K = proportionality constant for equations of the current formula's type, and
A_T = total area under area ORA
If A_T = 97.5 min·ft at t = 10 min, then

$$FSC = \frac{550}{10} = K \times 97.5,\ \text{and}$$

$$K = \frac{550}{10 \times 97.5} = 0.564$$

X2.2.1.5 Thus, the formula in 7.1.2 for areas (A_T) of 97.5 min·ft or less is as follows.

$$FSC = 0.564\, A_T$$

X2.3 Formula 2

X2.3.1 For total areas greater than 97.5 min·ft, calculate the flame spread as follows:

$$FSC = \frac{5363}{(195 - A_T)}$$

X2.3.1.1 In the idealized straight-line flame spread distance-time curve of Fig. X2.2, lines OI, OI', and OI'' produce a family of trapezoidal areas $ORBI$ ranging from 97.5 to 195 min·ft ($\frac{1}{2}$ by 10 min by 19.5 ft to 10 min by 19.5 ft) This represents a flame front progression to the end of the specimen within the 10 min of the test. The area (A_T) of $ORBI$ may be expressed as follows:

$$(\tfrac{1}{2}\ \text{by } 19.5\ \text{by } OR) + (\tfrac{1}{2}\ \text{by } 19.5\ \text{by } (10 - AI))$$

which is equal to

$$195 - 9.75\, AI$$

since OR is always 10 min

X2.3.1.2 The triangular area OIA divided into a proportionality constant K will determine a relationship between flame spread values and the rate and distance of flame propagation. The total area available is 195 min·ft, hence area OIA is equal to 195 - $ORBI$
Thus, a new flame spread formula may be derived as follows:

$$FSC = \frac{K}{OIA} = \frac{A}{195 - ORBI} = \frac{A}{195 - A_T}$$

X2.3.1.3 To establish K, a relationship between the current and the previous Method E 84 formulas will be established at the red oak calibration point of 19.5 ft progression at 5.5 min as follows

$$FSC = \frac{550}{t} = \frac{K}{195 - A_T}$$

where
A_T = 195 - (9.75 (5.5)) = 141.38 min·ft, and
t = 5.5 min.
Thus

$$FSC = \frac{550}{5.5} = \frac{A}{195 - 141.38},\ \text{or}$$

$$K = \frac{550 \cdot (53.63)}{5.5} = 5363$$

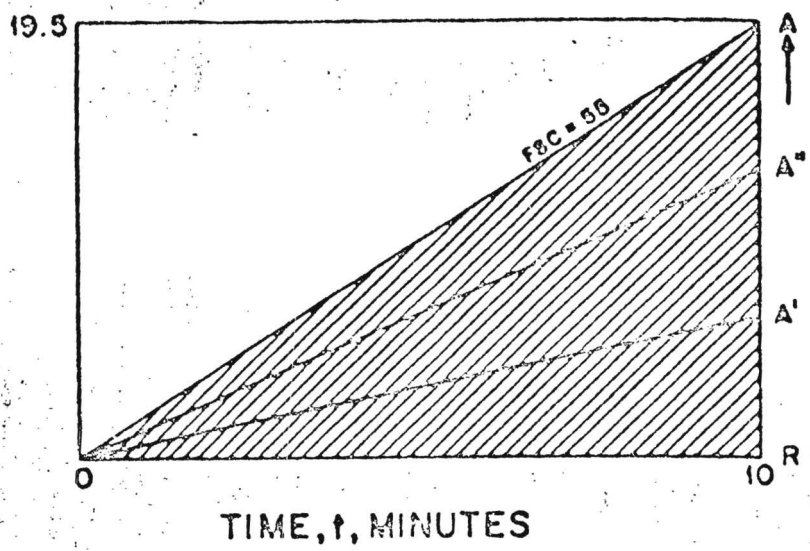X2.3.1.4 Thus the formula for flame spread classification in 7.1.3 is as follows:

$$FSC = \frac{5363}{195 - A_T}$$

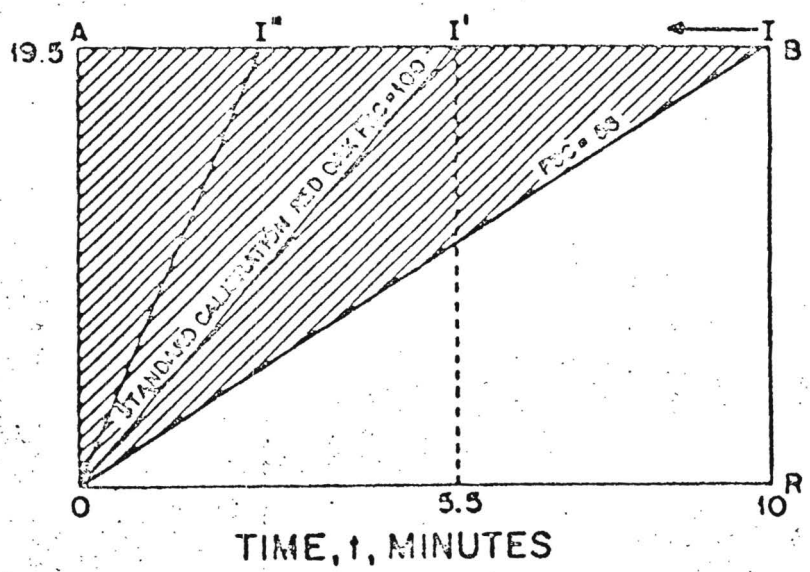FIG. X2.1 Idealized Straight-Line Flame Spread Distance-Time Curve for Total Areas Less than or Equal to 97.5 min ft.

FIG. X2.2 Idealized Straight-Line Flame Spread Distance-Time Curve for Total Areas Greater than 97.5 min ft.

H-29-10

ANSI/ASTM C 739 – 77[c]

Standard Specification for

CELLULOSIC FIBER (WOOD-BASE) LOOSE-FILL THERMAL INSULATION[1]

This Standard is issued under the fixed designation C 739; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

[e] NOTE—Section 10.4.2.3 was added editorially and 10.7.2.2 and 10.7.2.3 were corrected editorially in January 1978.

1. Scope

1.1 This specification covers the composition, types, and physical requirements of recycled cellulosic fiber (wood-base) loose-fill type thermal insulation for pneumatic and pouring application in building construction within the ambient temperature range from −50 to 180°F (−45.6 to 82.2°C).

NOTE 1—The values stated in U.S. customary units are to be regarded as the standard.

2. Applicable Documents

2.1 ASTM Standards:

C 168 Definitions of Terms Relating to Thermal Insulating Materials.[2]

C 177 Test for Steady-State Thermal Transmission Properties by Means of the Guarded Hot Plate.[3]

C 236 Test for Thermal Conductance and Transmittance of Built-Up Sections by Means of the Guarded Hot Box.[3]

C 390 Sampling Preformed Thermal Insulation.[3]

C 518 Test for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter.[2]

C 519 Test for Density of Fibrous Loose Fill Building Insulations.[2]

C 687 Recommended Practice for Determination of the Thermal Resistance of Low-Density Fibrous Loose Fill-Type Building Insulation.[2]

D 591 Test for Starch in Paper.[4]

E 84 Test for Surface Burning Characteristics of Building Materials (Appendix X1.6).[3]

3. Classification

3.1 The cellulosic fiber (wood-base) loose-fill type thermal insulation covered by this specification is of two types:

3.1.1 *Type I*—Flame Spread Classification 0–25.

3.1.2 *Type II*—Flame Spread Classification 26–50.

4. Materials and Manufacture

4.1 The basic material shall be recycled wood-based cellulosic fiber made from selected paper or paperboard stock, excluding contaminated materials which may reasonably be expected to be retained in the finished product. Suitable chemicals may be introduced to provide improved properties such as flame resistance, processing, and handling characteristics.

4.2 The basic material may be processed into a form suitable for installation by pneumatic or pouring methods.

5. Definitions

5.1 The applicable definitions in Definitions C 168 shall apply to the terms used in this specification.

6. Ordering Information

6.1 The type suitable for the conditions of intended service, and applicable building code if any shall be specified by the purchaser.

7. Physical Requirements

7.1 *Density*—The density shall be determined in accordance with 10.1.

7.2 *Thermal Resistance*—The standard thermal resistance values recommended for application are: 13, 19, 24, 32, 40,[*] and are expressed in deg F·h·ft²/Btu (or K·m²/W). The average thermal resistance, *R*, shall not be more than 5% below the listed *R* value when tested in accordance with 10.2. *R* values other than those listed shall be agreed upon between the supplier and the purchaser.

7.3 *Surface Burning Characteristics*—The insulation material when tested in accordance with 10.3 shall be classified into one of the types listed in 3.1.

7.4 *Flame Resistance Permanency*—The permanence of the flame retardants used shall be determined by subjecting the insulation to accelerated aging conditions in accordance with 10.4.

7.5 *Moisture Absorption*—Moisture gain in the insulation shall be no more than 15 weight % after being subjected to test method 10.5.

7.6 *Odor Emission*—A detectable odor of objectionable nature recorded by two of the three panel observers will constitute rejection of the material when tested in accordance with 10.6.

7.7 *Corrosiveness*—The composition of the material shall be such that no corrosion of metal building materials shall occur when tested in accordance with 10.7.

7.8 *Starch*—The insulation shall be tested for starch content in accordance with 10.8.

8. Workmanship

8.1 The product shall be free of extraneous foreign materials such as metals and glass which will adversely affect the performance in service.

9. Sampling

9.1 For purposes of standard tests, sampling shall be in accordance with Plan B of Method C 390.

10. Test Methods

10.1 *Density*—Determine the density in accordance with Method C 519.

10.2 *Thermal Resistance*—To determine conformance with the standard thermal resistances and required thicknesses called for in 7.2 and 12.2, use the following procedure:

10.2.1 Use Method C 518, conducted in accordance with Recommended Practice C 687 to determine thermal resistance. Report results at 75°F (23.9°C) mean temperature.

10.2.2 In case of question, determine referee test values on the required thickness in accordance with Methods C 177 or C 236, with evaluations performed, and results reported at a 75°F (23.9°C) mean temperature.

10.3 *Surface Burning Characteristics*—Determine the surface burning characteristics of the loose fill insulation in accordance with Method E 84 as modified in 10.3.1 and 10.3.2.

10.3.1 *Galvanized-Steel Screen Correction Factor*—Prior to performing the surface burning test, the operator shall develop a correction factor for the select grade red oak flooring, described in Method E 84, with the galvanized-steel screening, as described in Section X1.6 of the appendix to Method E 84, in place. The placement and fastening of the screening to the select grade red oak flooring shall be as shown in Fig. 1.

10.3.2 *Report of Surface Burning Characteristics*—The correction factor described in 10.3.1 shall be used in reporting the surface burning characteristics (flame spread classification) of cellulosic fiber (wood-base) loose-fill thermal insulation conforming to this specification.

10.4 *Flame Resistance Permanency:*

10.4.1 *Scope*—Subject the insulation to an accelerated aging procedure designed to determine the permanency of the chemicals used as fire retardants.

10.4.2 *Apparatus:*

10.4.2.1 *Humidity Chamber,* capable of maintaining 180 ± 3°F (82.2 ± 1.7°C) with 96 ± 3% relative humidity for high-temperature conditioning and 80 ± 3°F (26.7 ± 1.7°C) with 50 ± 3% relative humidity for low-temperature

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[*] To calculate the thermal resistance, *R*, of a wall, ceiling, or floor section in which the product is installed, thermal values of air films and other building materials making up the section and methods of calculation may be found in the ASHRAE "Handbook of Fundamentals."

conditioning.

10.4.2.2 *Flame Spread Test Apparatus, 2-ft.*[6,7].

Note 2—When a materials flame spread rating, as found in 10.3, is within 20 % of a higher classification as in Method E 84 in 10.3 of this specification, a 25-ft tunnel must be used in place of the 2-ft apparatus. (Example 20 % of 75 = 15, therefore a flame spread rating of 60 or greater requires the E 84 tunnel as modified in this specification.)

10.4.2.3 *This standard should be used to measure and describe the properties of materials, products, or systems in response to heat and flame under controlled laboratory conditions and should not be used for the description or appraisal of the fire hazard of materials, products, or systems under actual fire conditions.*

10.4.2.4 *Laboratory Scales,* capable of weighing to the nearest 0.1 g.

10.4.3 *Procedure:*

10.4.3.1 *Specimens*—Submit a representative sample of the insulation for test, portions of which shall be used for each test.

10.4.3.2 Prepare two specimens of at least 100 g each and not less than 2 in. (51 mm) thick.

10.4.3.3 Condition specimens for 24 h at 80 ± 3 F (26.7 ± 1.7 C) and 50 ± 3% relative humidity.

10.4.3.4 Conduct a flame spread and fuel contribution test on one specimen in the 2-ft apparatus and record the results.

Note 3—The screening used to support the specimen properly shall be in accordance with Appendix A1.6 of Method E 84. The 2-ft apparatus shall be calibrated and operated as outlined in H. L. Vandersall's article.

10.4.3.5 Age the second specimen in the humidity chamber as follows:

24 h at 180 ± 3°F (82.2 ± 1.7°C) and 96 ± 3% relative humidity

24 h at 80 ± 3°F (26.7 ± 1.7°C) and 50 ± 3% relative humidity

24 h at 180 ± 3°F (82.2 ± 1.7°C) and 96 ± 3% relative humidity

24 h at 80 ± 3°F (26.7 ± 1.7°C) and 50 ± 3% relative humidity

10.4.3.6 Conduct a flame spread and fuel contribution test on the aged specimen.

10.4.4 *Report*—The report shall include the following:

10.4.4.1 Temperatures, relative humidity, and exposure times of aging procedure.

10.4.4.2 A numerical determination is made of flame spread and fuel contribution of the aged specimen and the non-aged specimen. When there is an increase in flame spread of 20% or more of the aged specimen in the 2 ft apparatus, the flame resistance permanency test must be repeated using the Method E 84 25-ft tunnel as modified in this specification.

10.4.4.2.1 A change in flame spread classification in the 25-ft tunnel as modified in this specification shall constitute failure of the test.

10.5 *Moisture Absorption*—The test specimen shall be a sample of approximately 100 g.

10.5.1 Condition at 50 ± 2% relative humidity and 120°F (48.9°C) to constant weight and record weight. Then increase the relative humidity to 90 ± 2% and recondition for 24 h and record weight. Determine the hydration as moisture absorption by weight.

10.5.2 *Calculations*—Calculate the percentage moisture absorption by weight as follows:

Moisture absorption, weight %

$$= [(w_1 - w_1)/w_1] \times 100$$

where:
w_1 = weight after test
w_1 = weight of conditioned sample at 50% relative humidity.

10.5.3 *Report*—The report shall include all test conditions such as temperature, relative humidity, and exposed time. Moisture absorption in excess of 15 weight % shall constitute failure of test.

10.6 *Odor Emission:*

10.6.1 *Test Specimen*—Prepare three 50-g specimens of insulation.

10.6.2 *Apparatus and Materials:*

10.6.2.1 *Electric Refrigerator.*

10.6.2.2 *Pans*—Six porcelain enameled or stainless steel refrigerator pans having at least 50 in.[2] (322.6 cm²) of surface area by 3½ in. (88.9 mm) deep, with snug-fitting lids.

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[6] This is not an ASTM test method, but is used here as a check test. Therefore, the flame resistance permanency test is not necessarily suitable for other materials. Its use does not imply that there is a correlation with the Method E 84 tunnel as modified in this specification. A detailed description of this apparatus with construction drawings appears in an article by Vandersall, H. L., "The Use of a Small Flame Tunnel for Evaluating Fire Hazard," *Journal of Paint Technology,* JPTY, Vol 39, No. 511, August 1967, pp. 494-500.

[7] A Custom Scientific Instruments 2-ft flame spread test tunnel has been found satisfactory for this purpose, Model C-196-CL.

10.6.2.3 *Glass Squares*—Six 2-in. (50.8-mm) square pieces of window glass or small watch glasses of equal area.

10.6.2.4 *Butter*, unsalted, sweet cream, less than 72 h old, cut into pats 1 in. (25.4 mm) square by ¼ in. (6.4 mm) thick.

10.6.2.5 *Care of Apparatus*—All equipment shall be kept odor-free. Before each test, the pans, glass squares, and the knife with which the butter is cut shall be sterilized. The refrigerator must be kept free of odor and in good operating condition at all times.

10.6.3 *Procedure:*

10.6.3.1 Place the six pats of butter on the six sterilized squares of glass. Place one piece of glass with butter thereon on top of each of the three insulation specimens; then place in separate pans. Place the other three pieces of butter in separate pans without insulation specimens to serve as blanks during the test. Replace the lids and place all pans into an electric refrigerator. Operate the refrigerator at normal temperature (40°F) (4.4°C) for 24 h, at which time remove the pans and make the odor test within 1 h.

10.6.3.2 Observations of odor emission shall be made by at least three observers. After removing the pans from the refrigerator, raise the lids of each pan slightly at one end then allow the lids to drop. Note and record any odor expelled, comparing in each case the odor from a pan containing an insulation specimen with that from a pan without insulation specimen.

10.6.4 *Report*—The report shall include all observations of the odor test, classified as follows: 1) no apparent difference; 2) slight trace, or 3) strong or objectionable. A detectable odor of strong or objectionable nature recorded by two of the three panel observers will constitute failure of the material.

10.7 *Corrosiveness:*

10.7.1 *Scope*—The insulation material shall be tested to determine the corrosive properties resulting from water and moisture vapor acting on the fibers, migrating varying amounts of chemical constituents to the insulation surfaces which may react with metal sidings and other metallic building materials. It should be noted that this is an accelerated test intended to duplicate moisture vapor and chemical migration to colder areas and condensing of metallic surfaces.

10.7.2 *Apparatus and Materials:*

10.7.2.1 *Humidity Chamber*, capable of maintaining 120 ± 3°F (48.9 ± 1.7°C) and 96 ± 3% relative humidity.

10.7.2.2 *Crystallizing Dishes*, two, 90-mm diameter by 50 mm high.

10.7.2.3 *Test Specimens*, two each, 2 by 2-in. (50.8 by 50.8-mm) by 0.003-in. (0.0762-mm) thick metal free of tears, punctures, or crimps as follows:

(*1*) 2024-T3 Bare Aluminum

(*2*) ASTM B 152, Type ETP, Cabra No. 110, soft copper

(*3*) Low-carbon, commercial quality, cold rolled, shim steel

10.7.2.4 *Trichloroethylene*, analytical reagent.

10.7.3 *Specimen*—A representative sample of the insulation shall be submitted for test, portions of which shall be used for each test.

10.7.4 *Procedure:*

10.7.4.1 Wash the metal specimens with trichloroethylene to remove any oil or grease. Dry at room temperature.

10.7.4.2 Pre-saturate the insulation samples by mixing 20 g of insulation with 150 ml of distilled water at room temperature for each test specimen.

10.7.4.3 Place a ½-in. (12.7-mm) thick layer of saturated insulation into an evaporating dish, tamp level, and place metal specimen. Cover the metal specimen with the remaining insulation and tamp to assure good contact with the metal plate. Cover with nonmetallic screen to prevent spilling during test.

10.7.4.4 Place the composite specimens and a control metal specimen into the humidity chamber, calibrated at 120°F (48.9°C) and 96 ± 3% relative humidity, for 168 h.

10.7.4.5 Upon completion of the test, thoroughly wash the metal specimens under running water and lightly brush them to remove loose corrosion products. Remove the remaining corrosion products by immersing them in 10 parts distilled water and 1 part nitric acid, 15.9 N. Rinse the samples in water and dry.

10.7.4.6 Make two duplicate tests for each determination.

10.7.5 *Report*—The report shall include the following:

10.7.5.1 Temperature, relative humidity,

and exposure time.

10.7.5.2 *Comparison of corrosion between insulated panel and control panel.* When minor surface etching occurs on the insulated aluminum or copper panels, extended 30-day tests must be conducted to determine additional corrosion effect. Extended 30-day tests are conducted on the steel panel only when corrosion of the insulated steel panel compares unfavorably with that of the control steel panel.

10.7.5.3 *Noncorrosiveness* shall be determined by the absence of any perforations when the metal specimen is observed over a chrome reflected 40-W appliance light bulb.

10.8 *Starch*—The material shall be tested in accordance with Method D 591 using the qualitative test procedure.

11. Inspection

11.1 Inspection of the insulation shall be made as agreed upon by the purchaser and the manufacturer as part of the purchase contract.

12. Packaging and Marking

12.1 *Packaging*—Unless otherwise specified the insulation shall be packaged in the manufacturer's standard commercial containers.

12.2 *Marking*—The markings shall be legible and at least ⅛ in. (3.2 mm) high. Unless otherwise specified, each container shall be marked with the supplier's name, type, coverage area per container, R value, expressed as a whole number, and the required thickness to obtain the thermal resistance.

12.2.1 A suggested label is as follows:

To obtain an insulation resistance (R) of:	Installed insulation should be not less than:	Contents of this bag should not cover more than	The weight per unit area of installed insulation should be not less than:
Open Fill 40	—— in. thick	—— ft²	—— lb/ft²
	—— mm thick	—— m²	—— kg/m²
Open Fill 32	—— in. thick	—— ft²	—— lb/ft²
	—— mm thick	—— m²	—— kg/m²
Open Fill 24	—— in. thick	—— ft²	—— lb/ft²
	—— mm thick	—— m²	—— kg/m²
Open Fill 19	—— in. thick	—— ft²	—— lb/ft²
	—— mm thick	—— m²	—— kg/m²
Open Fill 13	—— in. thick	—— ft²	—— lb/ft²
	—— mm thick	—— m²	—— kg/m²
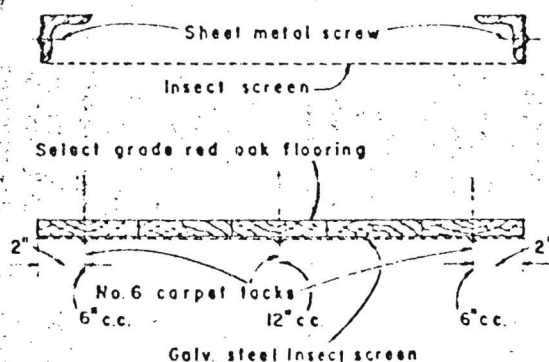
FIG. 1 Placement and Fastening of Screening to Select Grade Red Oak Flooring.

APPENDIX B

ACCESSION NUMBER   CA89-79191(2)
TITLE   Fireproofing of cellulose
AUTHORS   Ueno, Keisuke
ORGANIZATIONAL SOURCE   Japan
SOURCE   Japan. Kokai 7806609, 2 pp.. 1/21/78 Pat
                        App/Prty = 7677914, 7/2/76. PCL D21H-003/12
DOCUMENT TYPE   P (Patent)
CATEGORY CODES   SEC43-6
INDEX TERMS   57-13-6, reaction products with phosphoric
                        acid: 7664-38-2, reaction product with urea:
                        (fireproofing agents, contg. starch or
                        hydroxymethylcellulose, for pulp)
INDEX TERMS   9005-25-8, uses and misc: 37353-59-6:
                        (phosphoric acid-urea reaction products
                        contg., for fireproofing of pulp)
INDEX TERMS   Fireproofing agents: (phosphoric acid-urea
                        reaction products, contg. starch or
                        hydroxymethylcellulose, for pulp)
INDEX TERMS   Pulp, cellulose: (fireproofing agents for,
                        mixts. of phosphoric acid-urea reaction
                        products and starch or hydroxymethylcellulose
                        as)
SUPPLEMENTARY TERMS   phosphorus: compd
                        chloride-terminated: 60836-89-7,
                        benzenesulfonyl chloride-terminated:
                        (fireproofing agents, for rayon)
INDEX TERMS   Fireproofing agents: (polyphosphonates, for
                        rayon)
INDEX TERMS   Rayon, uses and misc: (fireproofing agents
                        for, polyphosphonates as)
SUPPLEMENTARY TERMS   agent: polyphosphonate: cyclic: copolymer

ACCESSION NUMBER   CA88-91327(14)
TITLE   Fire-retardant and anti-flame compositions
                        for cellulose-base materials
AUTHORS   Frankow, Terez: Rosner, Laszlo: Somogyi.
                        Dezso: Szabo, Ferenc
ORGANIZATIONAL SOURCE   Hung.
SOURCE   Hung. Teljes 14116, 21 pp.. 10/28/77 Pat
                        App/Prty = 979. 10/13/75. PCL C09K-000/00
DOCUMENT TYPE   P (Patent)
CATEGORY CODES   SEC43-7
INDEX TERMS   144-55-8. uses and misc: 7783-20-2, uses and
                        misc: 7783-28-0: (fireproofing agents, for
                        paper)
INDEX TERMS   Fireproofing agents: (ammonium sulfate,
                        diammonium phosphate and sodium bicarbonate,
                        for paper)
INDEX TERMS   Paper: (fireproofing of, with ammonium
                        sulfate, diammonium phosphate and sodium
                        bicarbonate)
INDEX TERMS   Wood: (fireproofing of, with inorg. compds.)
SUPPLEMENTARY TERMS   agent

ACCESSION NUMBER   CA87-203331(26)
TITLE   Agents for fireproofing cellulosic materials
AUTHORS   Oshino, Shinichi: Kozama, Mihoko: Yamashita,
                        Motoharu
ORGANIZATIONAL SOURCE   Sanwa Chemical Co., Ltd., Japan.
SOURCE   Japan. Kokai 7796216, 3 pp.. 8/12/77 Pat
                        App/Prty = 7610167, 2/2/76. PCL D21H-003/12
DOCUMENT TYPE   P (Patent)
CATEGORY CODES   SEC43-7
INDEX TERMS   64712-19-2: (fireproofing agents, for paper)
INDEX TERMS   50-01-1: (fireproofing agents, sodium
                        hypophosphite, for paper)
INDEX TERMS   7681-53-0: (fireproofing agents, contg.
                        guanidine hydrochloride, for paper)
INDEX TERMS   Paper: (fireproofing agents for, guanidine
                        hypophosphite or guanidine
                        hydrochloride-sodium hypophosphite mixts. as)
INDEX TERMS   Fireproofing agents: (guanidine hypophosphite
                        or guanidine hydrochloride-sodium
                        hypophosphite mixts., for paper)
SUPPLEMENTARY TERMS   fireproofer

ACCESSION NUMBER   CA89-181438(22)
TITLE   Fireproofing agents for cellulosic materials
AUTHORS   Ohta, Hayao; Hirotsu, Isamu; Yamashita, Motoji
ORGANIZATIONAL SOURCE   Sanwa Chemical K. K., Japan
SOURCE   Japan. Kokai 7899697, 8 pp., 8/31/78 Pat
                           App/Prty = 7712940, 2/10/77. PCL CO9K-003/28
DOCUMENT TYPE   P (Patent)
CATEGORY CODES   SEC43-7
INDEX TERMS   451-58-5: (fireproofing agents, contg.
                           guanidine sulfamate and diammonium phosphate,
                           for wallpaper)
INDEX TERMS   7722-76-1; 7783-28-0; 13597-86-9; Phosphates,
                           uses and misc: (fireproofing agents, contg.
                           guanidine sulfamate and dicyandiamide, for
                           wallpaper)
INDEX TERMS   50979-18-5: (fireproofing agents, contg.
                           dicyandiamide and diammonium phosphate, for
                           wallpaper)
INDEX TERMS   Fireproofing agents: (guanidine sulfamate,
                           contg. dicyandiamide and ammonium phosphate,
                           for wallpaper)
INDEX TERMS   Paper, wall-: (fireproofing agents for,
                           guanidine sulfamate and dicyandiamide and
                           ammonium phosphate as)

ACCESSION NUMBER   CA89-165150(20)
TITLE   Interim safety standard for cellulose
                           insulation
AUTHORS   Anon.
ORGANIZATIONAL SOURCE   Consumer Prod. Saf. Comm., Washington, D. C.
SOURCE   Fed. Regist. (FEREAC), V 43 (153), p.
                           35240-58, 8/8/78, ISSN 00976326
DOCUMENT TYPE   J (Journal)
LANGUAGE   Eng
CATEGORY CODES   SEC43-3; SEC59
INDEX TERMS   9004-34-6, uses and misc: (thermal
                           insulation, Federal Registry safety stds. for)
INDEX TERMS   Corrosion: (by cellulose thermal insulation,
                           Federal Registry stds. for)
INDEX TERMS   Flammability: (of cellulose insulation,
                           Federal Registry stds. for)
INDEX TERMS   Labels: (for cellulose thermal insulation,
                           Federal Registry stds. for)
INDEX TERMS   Standards, legal and permissive: (for
                           cellulose thermal insulation, Federal
                           Registry)
INDEX TERMS   Thermal insulators: (cellulose, Federal
                           Registry safety stds. for)
SUPPLEMENTARY TERMS   std; flame; resistance

ACCESSION NUMBER   CA89-91327(12)
TITLE   Flameproofing process
AUTHORS   Miller, Glyn; Lowe, Edward James; Stephenson,
                           James Edward
ORGANIZATIONAL SOURCE   Albright and Wilson Ltd., Engl.
SOURCE   Brit. 1504507, 7 pp., 3/22/78 Pat App/Prty =
                           7355555, 11/29/73, PCL DO6M-011/08
DOCUMENT TYPE   P (Patent)
CATEGORY CODES   SEC43-1; SEC39
INDEX TERMS   57-13-6, uses and misc: (fireproofing compns.
                           contg. ammonium polyphosphates and, for
                           cellulosic materials)
INDEX TERMS   Building materials, fiberboards; Paper,
                           kraft; Rayon, uses and misc; Wood:
                           (fireproofing of, ammonium polyphosphate-urea
                           compns. for)
INDEX TERMS   Fireproofing agents: (ammonium
                           polyphosphate-urea compns. as, for cellulosic
                           materials)
INDEX TERMS   Polyphosphoric acids: (ammonium salts,
                           fireproofing agents, for cellulosic materials)
SUPPLEMENTARY TERMS   agent; cellulose; textile; timber; fiberboard

ACCESSION NUMBER	CA89-76594(10)
TITLE	Smolder and flame resistant insulation materials, composition and method
AUTHORS	McCarter, Robert J.
ORGANIZATIONAL SOURCE	United States. Dept. of Commerce, USA
SOURCE	U. S. Pat. Appl. 870385, 16 pp. Avail NTIS., 1/18/78 Pat App/Prty = 870385, 1/18/78.
DOCUMENT TYPE	P (Patent)
CATEGORY CODES	SEC43-1
INDEX TERMS	1303-96-4; 1330-43-4; 1344-09-8; 10043-01-3; 10049-21-5; 10213-79-3; 13397-24-5, uses and misc: 21645-51-2, uses and misc: (flame retardants, contg. sulfur, for thermal insulators from milled newspaper)
INDEX TERMS	7704-34-9, uses and misc: (flame retardants contg.. for thermal insulators from milled newspaper)
INDEX TERMS	Fire-resistant materials: (milled newspapers contg. inorg. salts and sulfur)
INDEX TERMS	Paper, newsprint: (thermal insulators from milled, contg. fire retardants and sulfur)
INDEX TERMS	Thermal insulators: (milled newspaper contg. fire retardants and sulfur)
SUPPLEMENTARY TERMS	fiber; borax; insulator; pulp; cellulosic; material

ACCESSION NUMBER	CA89-45339(6)
TITLE	Water-soluble flame-resisting agent for cellulose-containing materials
AUTHORS	Seeholzer, Josef
ORGANIZATIONAL SOURCE	Sueddeutsche Kalkstickstoff-Werke A.-G., Ger.
SOURCE	Ger. Offen. 2653739. 9 pp., 6/1/78 Pat App/Prty = 2653739, 11/26/76. PCL C08K-005/29
DOCUMENT TYPE	P (Patent)
CATEGORY CODES	SEC43-7
INDEX TERMS	50-00-0, uses and misc: (fireproofing agents, contg. aluminum sulfate and dicyandiamide, for paper)
INDEX TERMS	461-58-5: (fireproofing agents, contg. aluminum sulfate and formaldehyde, for paper)
INDEX TERMS	10043-01-3: (fireproofing agents, contg. dicyandiamide and formaldehyde, for paper)
INDEX TERMS	Fireproofing: (agents for, aluminum sulfate contg. dicyandiamide and formaldehyde as, for paper)
INDEX TERMS	Paper: (fireproofing agents for, aluminum sulfate contg. dicyandiamide and formaldehyde as)

ACCESSION NUMBER	CA085140959689P
TITLE	CHEMISTRY OF COMBUSTION RETARDATION IN CELLULOSE MATERIALS
AUTHORS	MIHALIK, P.
ORGANIZATIONAL SOURCE	ICHEM. PRAGUE
LOCATION	CZECH.
SOURCE	HORENIE ORG. MATER., (ZB. PREDNASOK) 105-20
JOURNAL CODEN	32QWAX
PUBLICATION YEAR	75
PUBLISHER	DOM TECH. SVTS ZILINA, CZECH
DOCUMENT TYPE	C
LANGUAGE	CZECH
CATEGORY CODE	CA043000
INDEX TERMS	REVIEW CELLULOSE MATERIAL FIREPROOFING

ACCESSION NUMBER CA87-186335(24)
TITLE Fireproofing agents for cellulosic materials
AUTHORS Oshino, Shinichi; Ozawa, Mihoko; Yamashita, Motoji
ORGANIZATIONAL SOURCE Sanwa Chemical Co., Ltd., Japan
SOURCE Japan. Kokai 7781999, 6 pp., 7/8/77 Pat App/Prty = 75157132, 12/27/75. PCL C09K-003/28
DOCUMENT TYPE P (Patent)
CATEGORY CODES SEC43-7
INDEX TERMS 50979-18-5: (fireproofing agents, contg. phosphates, for paper)
INDEX TERMS 7558-80-7; 7778-77-0; 7553-79-4; 7758-11-4; 7722-88-5; 7320-34-5; 7753-29-4; 14986-84-6; 10124-56-8; 13708-85-5; 7681-53-0; 64663-11-2; 42975-40-6: Phosphates, uses and misc: (fireproofing agents, contg. guanidine sulfamate, for paper)
INDEX TERMS Paper: (fireproofing agents for, guanidine sulfamate and phosphates as)
INDEX TERMS Fireproofing agents: (guanidine sulfamate and phosphates, for paper)
SUPPLEMENTARY TERMS agent; phosphate

ACCESSION NUMBER CA87-169222(22)
TITLE Compositions for fireproofing cellulosic materials
AUTHORS Noguchi, Isamu; Ueyama, Michio
ORGANIZATIONAL SOURCE Furukawa Electric Co., Ltd., Japan
SOURCE Japan. Kokai 7773598, 4 pp., 6/20/77 Pat App/Prty = 75148426, 12/15/75. PCL C09K-003/28
DOCUMENT TYPE P (Patent)
CATEGORY CODES SEC39-10; SEC43
INDEX TERMS 1303-96-4; 11113-50-1; 10043-01-3; 7758-29-4: (fireproofing agents, for paper)
INDEX TERMS 14986-84-6: (fireproofing agents, for rayon)
INDEX TERMS Castor oil, sulfated: (fireproofing compn. contg., for rayon)
INDEX TERMS Rayon, uses and misc: (fireproofing agents for, borax-boric acid-aluminum sulfate-sodium tetrapolyphosphate-Turkey-red oil mixts. for)
INDEX TERMS Paper: (fireproofing agents for, borax-boric acid-aluminum sulfate-sodium tripolyphosphate-Turkey-red oil mixts. for)
INDEX TERMS Fireproofing agents: (borax-boric acid-aluminum sulfate-polyphosphoric salt-Turkey-red oil mixts., for rayon or paper)
SUPPLEMENTARY TERMS fabric; polyphosphate; agent

ACCESSION NUMBER CA084221525071
TITLE FLAME-RESISTANT REGENERATED CELLULOSE
AUTHORS MAURIC, CLAUDINE; WOLF, RAINER
PATENT ASSIGNEES SANDOZ-PATENT-G.M.B.H.
LOCATION GER.
SOURCE GER. OFFEN. 25 PP.
JOURNAL CODEN GWXXBX
PUBLICATION YEAR 19 FEB 76
PATENT NUMBER 2532521
PATENT CLASSIFICATION C08K
PATENT DATE 300774
PATENT PRIORITY DATE 10,463/74
PATENT LOCATION SWISS
DOCUMENT TYPE P
CATEGORY CODE CA043003
INDEX TERMS DIOXAPHOSPHORINANE DERIV FIREPROOFING CELLULOSE

ACCESSION NUMBER   CA08324195591N
TITLE   FLAME-RETARDANT CELLULOSIC MATERIALS
AUTHORS   MILLER, GEORGE T.
PATENT ASSIGNEES   HOOKER CHEMICALS AND PLASTICS CORP.
LOCATION   USA
SOURCE   U.S. 4 PP.
JOURNAL CODEN   USXXAM
PUBLICATION YEAR   19 AUG 75
PATENT NUMBER   3900327
PATENT CLASSIFICATION   106-15FP; C09D
PATENT DATE   121073
PATENT PRIORITY DATE   405.962
DOCUMENT TYPE   P
CATEGORY CODE   CA043007
INDEX TERMS   OXIRANE PHOSPHORYLATED FIREPROOFING PAPER

ACCESSION NUMBER   CA08314116884J
TITLE   MODIFICATION OF CELLULOSE MATERIALS
AUTHORS   ABIDOV, S.R.; MURATOVA, U.M.; YULDASHEV,
                        A.YU.; GAFUROV, T.G.; USMANOV, KH.U.
LOCATION   USSR
SOURCE   U.S.S.R.
JOURNAL CODEN   URXXAF
PUBLICATION YEAR   14 JUN 75
ABSTRACT CITATION   OTKRYTIYA, IZOBRET., PROM. OBRAZTSY, TOVARNYE
                        ZNAKI 1975, 52(22), 51
PATENT NUMBER   473722
PATENT CLASSIFICATION   C08B
PATENT DATE   310572
PATENT PRIORITY DATE   1.791.287
DOCUMENT TYPE   P
CATEGORY CODE   CA039010
INDEX TERMS   FIREPROOFING CELLULOSIC MATERIAL
INDEX TERMS   CREASEPROOFING CELLULOSIC MATERIAL
INDEX TERMS   PHOSPHATE DIISOCYANATE TREATMENT CELLULOSE

ACCESSION NUMBER   CA082140878990
TITLE   COMBUSTION OF CELLULOSIC MATERIALS AND ITS
                        RETARDANCE. STATUS AND TRENDS. I.
                        IGNITION, COMBUSTION PROCESSES, AND SYNERGISM
AUTHORS   JUNEJA, S.C.
ORGANIZATIONAL SOURCE   CAN. FOR. SERV., CANADA DEP. ENVIRON., OTTAWA
LOCATION   ONT.
SOURCE   WOOD SCI. 7 3 201-8
JOURNAL CODEN   WOSCBV
PUBLICATION YEAR   75
DOCUMENT TYPE   J
LANGUAGE   ENG
CATEGORY CODE   CA043000
INDEX TERMS   REVIEW PAPER IGNITION
INDEX TERMS   COMBUSTION PAPER REVIEW
INDEX TERMS   FIRE RETARDANT SYNERGISM REVIEW

ACCESSION NUMBER   CA082060323l5R
TITLE   NEW DURABLE FLAME RETARDANT FOR CELLULOSICS
AUTHORS   EISENBERG, B.J.; WEIL, E.D.
ORGANIZATIONAL SOURCE   STAUFFER CHEM. CO., DOBBS FERRY
LOCATION   N. Y.
SOURCE   TEXT. CHEM. COLOR. 6 8 180-2
JOURNAL CODEN   TCCOB6
PUBLICATION YEAR   74
DOCUMENT TYPE   J
LANGUAGE   ENG
CATEGORY CODE   CA039010
INDEX TERMS   SAFETY METHYLOLACRYLAMIDE VINYLPHOSPHONATE
                        OLIGOMER
INDEX TERMS   FIREPROOFING CELLULOSIC TEXTILE
INDEX TERMS   CROSSLINKING AGENT METHYLOLACRYLAMIDE
INDEX TERMS   CATALYSTS CROSSLINKING POTASSIUM PERSULFATE
INDEX TERMS   METHYLOLACRYLAMIDE FINISHING AGENT
INDEX TERMS   VINYLPHOSPHONIC FIREPROOFING AGENT
INDEX TERMS   PHOSPHONIC DERIV FIREPROOFING AGENT
INDEX TERMS   PERSULFATE CROSSLINKING CATALYST
INDEX TERMS   FYROL 76 FIREPROOFING AGENT

ACCESSION NUMBER   ERDA-77-23
TITLE   Survey of Cellulosic Insulation Materials
ORGANIZATIONAL SOURCE Energy Research and Development
                      Administration. Washington. D.C. Div. of
                      Industrial Energy Conservation.
PAGINATION/DATE   Jan 77; 19p
ISSUE   U7726
NTIS PRICES   NTIS Prices: PC A02/MF A01
CATEGORY CODES   13A; 13C; 89G
INDEX TERMS   *Houses; *Thermal insulation; Cellulose;
                      Flammability; Moisture; Performance testing;
                      Physical properties; Quality control;
                      Specifications
SUPPLEMENTARY TERMS   ERDA/320101; ERDA/380603; NTISERDA

ABSTRACT   Cellulosic material manufactured from waste
                      paper products has been used for several
                      decades for residential thermal insulation
                      and currently is second only to fiber glass
                      as a home insulation material. In order to
                      provide a better understanding of cellulosic
                      material, to improve the quality of
                      insulation made from the material, and to
                      promote energy conservation, 19 samples of
                      commercially available cellulosic insulation
                      were tested for composition and quantity of
                      fire retardant; moisture absorptivity; fire
                      retardance; thermal conductivity;
                      corrosiveness; and resistance to fungal
                      growth. The results of these tests indicate
                      the need for improved standard
                      specifications. It is recommended that the
                      performance and product quality criteria for
                      cellulosic insulation be reevaluated and
                      defined; that manufacturers comply with these
                      specifications, and that the consumer should
                      insist that materials meet the
                      specifications. (ERA citation 02:045778)

ACCESSION NUMBER   Pb-233 805/1
TITLE   Carbohydrate-Boron Alkoxide Compounds.
TITLE NOTE   Patent Application
AUTHORS   Arthur. Jett C. jr; Bains. Malkiat S.
ORGANIZATIONAL SOURCE Department of Agriculture. Washington. D.c.
PAGINATION/DATE   Filed 15 Oct 73; 13p
ISSUE   U7419
NTIS PRICES   pc $4.00/MF $1.45
REPORT NOS.   Pat-Appl-406 408
CATEGORY CODES   7C; 7B; 90B
INDEX TERMS   *patent applications; *boron organic

ACCESSION NUMBER	Ad-701 957
TITLE	A proposed model for the decomposition of cellulose and the Effect of flame retardants.
TITLE NOTE	Final rept.
AUTHORS	Parker, William J.; Lipska, Anre E.
ORGANIZATIONAL SOURCE	Naval Radiological Defense Lab San Francisco Calif
PAGINATION/DATE	May 69; 57p
ISSUE	J7009
NTIS PRICES	nc $3.00 Mf $0.65
CONTRACT/GRANT NOS.	Dahc20-67-C-0149
PROJECT NOS.	Ccd-2531C
CATEGORY CODES	7D; 13L; 11E; 909; 941; 920
INDEX TERMS	(*cellulose, *pyrolysis); (*fire resistant materials, Cellulose); Fire resistant textiles; Thermogravimetric analysis; Molecular structure; Reaction kinetics; Degradation; Flammability
SUPPLEMENTARY TERMS	Glucosans; *flameproofing

ABSTRACT   A simplified model for the decomposition of cellulose is presented along with the effects of flame retardants on this model. It is supported by several specific laboratory tests. The basic hypothesis is that above 275C cellulose decomposes through the simultaneous unzipping of all the cellulose molecules, thus accounting for the constant rate of decomposition over most of the pyrolysis period. There is only one controlling reaction, namely unzipping, not competing reactions as usually postulated. The rate of decomposition is proportional to the number of molecules present which is essentially constant over most of the decomposition period. The lengths of the molecules decrease linearly with time. After the oxygen links between the glucosan units are broken during the unzipping process, the units can either be transformed into levoglucosan or participate in the char-forming process with the release of H_2O, Co_2, and H_2. The other observed products of pyrolysis come from the decomposition of the levoglucosan. The action of the flame retardants is to increase the rate of decomposition and the amount of char produced. The rate is increased by increasing the number of molecules through the breaking of inter-ring intramolecular bonds, or by increasing the unzipping rate through the breaking of intermolecular bonds. Direct action of the flame retardant on the levoglucosan causes the increase in char

DIGGING DEEP at California mine. U.S. Borax's recently completed expansion will be augmented with another capacity boost slated for completion in 1980.

Boron chemicals markets catch fire

Demand for flame-retarded cellulose insulation has surged in recent months, creating critical shortages of boric acid and sending producers scurrying to boost capacity

New market developments have been rare in the boron chemical business since the high-energy-fuels program faded into obscurity well over a decade ago. But within recent months, flame-retarded cellulose insulation demand has surged dramatically. As a result, there is a critical shortage of boric acid. Examples:

■ U.S. Borax and Chemical (USBC) completed a 30% expansion at its California plants only to find that another boost was needed. Another 30% expansion, due onstream about 1980, is now under way. It will cost over $50 million.

■ Imports of boron minerals and chemicals are running at twice the 1976 pace. Colemanite imports may top 60,000 tons for the year. Boric acid imports may total over 3,000 tons.

■ USBC plans to put a boron-chemical-based flame-retardant product on the market later this year. The idea is to get maximum utilization from available acid.

■ In Turkey, state-owned Etibank (Istanbul) plans to expand boric acid output to 150,000 tons/year by the early 1980s.

Hot Market: Explosive growth in cellulose insulation markets is the main reason for the strong demand for boric acid. It is used, often in conjunction with borax, to impart flame retardancy to cellulose fiber. The chemical is added dry to scrap newsprint, which is fluffed up by a mill.

About 20 lbs. of borate chemicals are required to treat 80 lbs. of newsprint. The ratio of boric acid to borax varies somewhat, depending on temperature and relative humidity. But, in general, it runs about 3 lbs. of boric acid to 7 lbs. of borax. Properly-treated cellulose insulation will meet an Underwriters Laboratory specification, a General Services Administration spec and one promulgated by National Cellulose Insulation Manufacturers Assn. (Elk Grove Village, Ill.), a trade organization that represents about 65% of the industry's capacity.

Scrap newsprint consumption, as reported by NCIMA members, is growing almost geometrically. In 1975, NCIMA members consumed 103,000 tons, and 146,000 tons were used last year. The forecast for 1977 is 230,000 tons—a whopping 64% jump. All of which suggests a market of 26,000 tons/year for boric acid alone in one application.

Boric acid capacity, with USBC's newest additions counted in, is now about 200,000 tons/year. The two USBC California plants can turn out an estimated 130,000 tons/year. Kerr-McGee has about 40,000-tons/year capacity at its Searles Lake, Calif., plant. And the Stauffer plant at San Francisco can produce about 35,000 tons/year from borate minerals it purchases. The new expansion planned by USBC, say marketers, will add 20-30% to capacity by about 1980. Boric acid production last year is estimated at 130-150,000 tons.

In recent years, demand for boric acid has fluctuated. In the early 1970s increases in demand from year to year were in the 10-15% range. But production dropped fractionally, to 140,000 tons, in 1974, and to 133,000 tons in 1975 as the recession and a housing slowdown took their toll. Stauffer's output last year was hampered by a strike.

Just how fast boric acid output will grow is subject to some uncertainty at present. About half of the domestic market for boron chemicals is used in glass and ceramic production, including insulation-grade glass fiber. Borate chemicals prevent flux leach-out, and borate demand (mainly as crude anhydrous borax) runs about 7% by weight of glass-fiber insulation produced.

The difficulty in estimating centers on

the extent to which surging cellulose insulation "cannibalizes" borate markets in glass-fiber production. Early indications are that cannibalization may be limited. Glass-fiber products are expected to get the nod in new construction where rolls can be easily laid down before walls and ceilings are finished.

The retrofit market (insulation for existing structures), however, belongs to products that can be blown or foamed into structural voids. Cellulose is estimated to have 30% of the retrofit market. Glass wool, mineral wool and plastic foams share the other 70%. Foam systems are now receiving heavy national promotion.

A second major uncertainty is the emergence of turn-key insulation plants that are designed for either stationary or truck mounting. Jaybee Co. (Tyler, Tex.) offers plants on an f.o.b. basis for $40,000-75,000 that can produce up to six bags containing 30 lbs. of product per minute, depending on the humidity. Business, says Jaybee, is booming. In North Dakota, Ideal Insulation (Jamestown) is marketing a $90,000 stationary plant with a 2-bags/minute capacity. In the past 15

control. A few horror stories of improperly prepared paper wool could besmirch the entire industry.

Come what may, however, it seems reasonably likely that cellulose insulation markets for borates will continue to grow rapidly. USBC is now developing a product that is thought to be an "extended" boric acid. The material may be on the market by late autumn. Although the company won't discuss details, the material may be some sort of optimized blend of boric acid and borax ground to the powder size needed by cellulose fiber plants. Aluminum sulfate and lime are also used to extend boric acid.

More Growth: Other boron chemical markets are also expanding, although at a considerably slower pace than boric acid. Last year, production of boron minerals and chemicals totaled 1.246 million short tons, a 6.3% gain over recession-ridden 1975. In terms of B_2O_3 content, the product sold or exported or consumed by U.S. producers totaled 630,000 tons—up about 4.4%.

The largest producer of borax and boron chemicals is USBC, and by a

uses will require over 300,000 tons in 1980.

Soap and detergent applications took 16.5% of the domestic boron action last year. The short-term growth rate will probably not exceed 3%/year, and demand should hit 56,300 tons in 1980. Detergent producers periodically promote "miracle" additives. If U.S. washing habits change in favor of the high temperature ranges typical in Europe, borate demand could expand rapidly. Sodium tetraborate is an effective bleach at high temperatures (over 160 F) and is widely used in European formulations.

Coating and plating applications are a relatively small market (34,000 tons in 1976); demand in 1980 will be about 40,000-44,000 tons. Agricultural markets are also relatively small and expanding at slightly less than 3%/year; 1980 demand: 27,000 tons.

Miscellaneous applications for boron products number in hundreds and there is a tiny but thriving trade in specialty boron products, including boron fibers. Flame retardants are now the largest component of the miscellaneous group. Last year retardants consumed about 23,000 tons of product, while remaining applications totaled 41,000 tons. By 1980, flame retardants for cellulose may exceed 55 million lbs.—assuming the historical 25% growth rate holds. Miscellaneous other uses will be near 50,000 tons by then. All in all, borate markets, exclusive of export demand could be about 440,000 tons in 1980.

Etibank is pumping $66 million into a plant in western Turkey. The thrust of new investment is aimed at increasing capacity for refined boron products

months, Ideal has sold 19 plants, is now backlogged and is producing two plants a week. The Small Business Administration has been active in promoting such ventures.

Truck-mounted units are now being promoted by Thermolator, a division of Toczek and Sons (Aurora, Colo.). Its unit, The Insulator, sells for $5,000, can produce 300-400 cu.ft./hour of borate-treated paper wool. Thermolator has plants in 16 states now, expects to have units in all 48 contiguous states within a few months.

Turn-key plants afford relatively easy entry into the insulation market and contribute to an explosive growth, which is difficult to project with any degree of assurance. Cellulose insulation makers believe the Carter Administration's insulation rebate idea will boost sales still more, feel confident that the recent heady pace will last at least a few more years. In contrast, glass-fiber insulation shipments last year were about 2 billion lbs., a gain of about 18%. Longer-term projections peg growth at 6-10%/year through 1980.

Members of NCIMA, however, are nervous about the advent of truck-mounted plants. The big worry is quality

considerable margin. Present company capacity in the U.S. is thought to be about 750,000 tons/year (as B_2O_3). The new expansion slated for 1980 could put the firm past the 900,000-tons mark.

Kerr-McGee has merged two plants at Searles Lake that were rated at 130,000 s.t./year (B_2O_3). The firm extracts boron values from brines. Although the company is putting in new soda ash capacity at the site, no decision is thought to have been reached concerning installation of new borate recovery. That decision will apparently wait until clear data on recovery economics are available.

American Borate Corp. (a subsidiary of Texas United) mines colemanite, probertite and ulexite in the Death Valley National Monument. Capacity: 60,000 tons/year (as B_2O_3). ABC has no plan to expand into downstream borates but wants to double capacity with a new, $20-million mine. A law passed last year (PL 94-429) will hamper mining in national parks and monuments areas.

Markets: In terms of domestic consumption, glass and ceramic applications last year accounted for 47% of the 340,000 tons (B_2O_3) of boron chemicals used. At a 6% annual growth rate, glass and ceramic

Export demand has traditionally been a major outlet for U.S. borate marketers, since the U.S. possesses about 32% of estimated world ore reserves (1.1 million tons). Exports of crude and refined boron products last year are estimated to be around 290,000 tons (as B_2O_3). What the future holds, however, is clouded by an ambitious development program in Turkey by Etibank, which took over four years ago when Rio Tinto Zinc (RTZ) liquidated its position. RTZ owns USBC and facilities in Argentina, as well.

Etibank is pumping $66 million into a plant at Kiykabur in western Turkey and is completing an expansion at Konya. The thrust of new investment is aimed at increasing capacity for refined boron products. Turkey can now process over 1 million tons of ore/year; the volume may double by the early 1980s. Foreign expansion may slow the rapid rise in prices. A $22/ton boost will raise f.o.b. boric acid prices to $265/ton next month, a 32% gain since 1975. The new price, however, is well below the $600/ton black market tab.

HOW TO MAKE AND INSTALL YOUR OWN INSULATION...
FOR 5¢ OR LESS A SQUARE FOOT!

Sometimes it's going to happen for the "right" reason (genuine dwindling reserves of the easily tapped fossil fuels on which our society has become so desperately hooked). Sometimes it's going to happen for the "wrong" reasons (Carter's fiasco of massive new government meddling and crushing taxes masquerading as an energy "plan", say, or profiteering by the utilities, multinational corporations, and others who supply the oil, gas, coal, electricity, etc., that we all use). And sometimes it's going to happen for both the right and the wrong reasons at the same time.

But for whatever reason or combination of reasons it takes place, there's no question about what's going to happen: The price of all the "traditional" (fossil fuel and fossil fuel-derived) energy you use from now on is going to go in just one direction . . . UP!

Oh, there'll be welcome little short-term reversals of that basic trend from time to time. (Right now, for instance—thanks to new production from Britain's North Sea fields, Mexico's sudden exports of oil, the opening of the North Slope in Alaska, increased pumping in Saudi Arabia last summer, and some other factors—the world is mildly awash in petroleum, and there's some rather frantic oil and gasoline price cutting going on behind the scenes.)

For all practical purposes, though, these fleeting discombobulations can be ignored (after, of course, you've taken maximum advantage of them whenever they present themselves). Keep your eye on the basic trend. And that very basic and very, very strong trend—now, and for as far into the future as you can possibly care to peer—is for the price of all "traditional" forms of energy to rise and rise and to keep on rising.

Then again, there's nothing engraved on a stone tablet anywhere that says you have to remain a big-time captive customer of the fossil fuel industry in the first place.

You might, for example, build and move into an Andy Davis-type underground house (see The Plowboy Interview in MOTHER NO. 46) . . . and then sail completely through the coldest winter in over 100 years (the winter of 1976—77) on only $1.29 worth of heating fuel the way Andy just did.

Or you might have David Wright, who now lives in a 93% heating and cooling self-sufficient home of his own design (see The Plowboy Interview in MOTHER NO. 47) draw up a set of plans for your family.

You could even have Jesse J. Savell (see "Here's a Passively Heated and Cooled House That You Can Afford . . . and Will Want" on pages 116—118 of this issue) put up one of his energy-miser dwellings for you.

BUT WHAT IF YOU CAN'T AFFORD TO MOVE INTO ONE OF THOSE NEW ENERGY-EFFICIENT HOMES?

"Well, that's all very nice," a number of you have recently told us, "and we certainly thank MOTHER for bringing these new breakthroughs in energy-efficient housing to our attention. But we can't afford a place like that just now. We're going to have to stay where we are for a while. And we aren't even sure we can afford that! What can we do right now to cut the amount of energy we'll have to use to keep our current home warm this winter? And don't tell us to have insulation installed . . . because we can't afford a bill for $300 or $400 or more for that either and, besides, most of the contractors who install insulation have a backlog of orders as it is."

YOU CAN MAKE AND INSTALL YOUR OWN INSULATION!

But who says you have to pay today's outrageous prices for insulation? (One contractor we know hiked his prices three times in the month of August alone!) And who says you have to put your name in the pot and then patiently wait days or even weeks until an insulating firm can get to you?

Nobody, that's who! Not when you can quickly, safely, and easily manufacture one of the best insulations ever devised. Not when you can make that insulation to equal or far exceed the specifications (fireproofing, vermin-proofing, etc.) of any manufacturer in the field. And not when you can do it all by yourself in your spare time and for just one-fifth or less of the out-of-pocket cost of what a probably inferior insulation would set you back if you hired a contractor to install it for you.

Yeah, sure. This all sounds too good to be true. But that's only because you've spent your whole life being brainwashed into The Perfect Little Consumer. And that's not your fault. Nowadays, even the mechanics and shop magazines (which, 30 years ago, would have given you exactly the sort of information that MOTHER is now gonna lay on you) maintain the polite—and, for you, expensive!—fiction that insulation somehow isn't actually insulation unless it comes in a trademarked bag and a "real" contractor installs it for you.

TAIN'T TRUE

Well, folks, that particular myth just ain't true. There may well be a bewildering selection of insulations on the current market. And some of them definitely are more fireproof . . . or more vermin-proof . . . or more water resistant . . . or easier to install in new construction . . . or easier to blow into old walls . . . or more this or less that than any of the others. But when it comes to downright cost effectiveness (even at contractor's prices), all-around availability, ease of installation under almost any conditions, minimum toxicity, and absolute minimum use of the planet's resources in a highly "natural" way . . . the all-time winner and champion always has, still is, and probably always will be . . . plain ole cellulose fiber.

Yep. Cellulose fiber. Which is nothing but old newspapers, cardboard boxes, and other kinds of waste paper . . . ground up fine . . . and treated with some readily available and inexpensive chemicals to make it self-extinguishing and vermin-proof.

It's hard to think of a more readily available, a simpler, or a less costly insulation . . . yet the "R" factor (the higher the

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CHART ONE: BURN TEST OF CELLULOSE INSULATION
Chemicals Added During Grinding

MIX NO.	INGREDIENTS BY WEIGHT		CONVERTED FOR 100 LBS. OF PAPER	RESULT	COST OF CHEMICAL		
					PER 100 LBS. OF PAPER	PER SQ. FT. 4" DEEP	PER SQ. FT. 6" DEEP
1	Paper	10 lbs.	100 lbs.	Burned like crazy	$ .80	$ .0054	$ .01
	Alum. Sulfate	.5	6				
	Borax	.25	2.5				
2	Paper	10 lbs.	100 lbs.	Burned	1.60	.0128	.02
	Alum. Sulfate	1	10				
	Borax	.5	5				
3	Paper	10 lbs.	100 lbs.	Burned slowly	2.40	.019	.03
	Alum. Sulfate	1.5	15				
	Borax	.75	7.5				
4	Paper	10 lbs.	100 lbs.	Burned very slowly	3.20	.025	.04
	Alum. Sulfate	2	20				
	Borax	1	10				
5	Paper	10 lbs.	100 lbs.	Self-extinguishing	4.00	.031	.05
	Alum. Sulfate	2.5	25				
	Borax	1.2	12				
6	Paper	10 lbs.	100 lbs.	Self-extinguishing	4.80	.038	.06
	Alum. Sulfate	3	30				
	Borax	1.5	15				

Borax cost: $15.00/100 lbs. Aluminum Sulfate cost: $8.50/100 lbs.

CHART TWO: BURN TEST ON CELLULOSE INSULATION
Chemicals Sprinkled on Cellulose After Insulation Was in Place

TEST NO.	INGREDIENTS BY WEIGHT/SQ. FT.		RESULTS	COST/SQ. FT.
1	Borax	1 oz.	Barely burned	$ .02
	Aluminum Sulfate	2 oz.		
2	Borax	2 oz.	Self-extinguishing	.04
	Aluminum Sulfate	4 oz.		
3	Borax	3 oz.	Self-extinguishing	.06
	Aluminum Sulfate	6 oz.		

Note: The insulation used in this test was from 4" to 6" in thickness.

..., the better) of each inch of insulation here is a very ... [unclear] 4. Even when you buy it ready-made, then, this is an extremely cost-effective insulation. And when you make it yourself your savings can really skyrocket!

That "makin'" is not in the least complicated either ... as MOTHER's researchers recently proved to themselves. It mainly consists of [1] gathering together enough bone-dry scrap cardboard or old newspapers, [2] running them through a farm-type hammermill set for its finest possible grind, [3] mixing in—either before or after the cellulose is ground—enough fireproofing and vermin repellent to protect it, and [4] putting the finished insulation where you want it.

USE A FARM-TYPE HAMMERMILL

The only "complication" we've found about this whole do-it-yourself project is that nothing less than a real, live, genuine *hammermill* will handle the grinding of the cellulose the way it should be handled. Little garden mulcher-type "shredder grinders" simply won't chew either paper or cardboard into the fluffy, fuzzy mass of fibers that makes the best insulation. (Rule of thumb: If you can still read whole words on your ground newsprint, it wasn't ground finely enough.)

What you want to do then (if you don't already have one) is rent or borrow or barter some time on one of the feed-grinding hammermills that many farmers own (the units are very much like the leaf grinders and limb shredders that you frequently see utility line crews using alongside the road).

Take care, too, to see that all the paper and cardboard you feed through the grinder is bone dry and stays that way (moisture can cause the shredded cellulose to "compost"). And always wear a respirator mask to protect your lungs from both paper dust and fine chemical particles as you work.

That last caution, by the way, is by no means meant to suggest that the chemicals used to treat the cellulose are in any way highly dangerous. Boric acid, the fire retardant used by most manufacturers of this insulation, is—as you probably know—so mild that doctors have frequently prescribed it as an eyewash. This particular fireproofer is now in such short supply, however (because of the current tremendous demand for insulation), that MOTHER's research crew has tested and presently recommends fireproofing cellulose insulation with borax. And borax, as you're surely aware, is so safe that it's the major ingredient in some laundry soaps.

The aluminum sulfate listed here as a rodent and insect repellent can best be put into perspective when you realize that it's one of the chemicals generally called "alum" (even though the term is more accurately descriptive of a double sulfate of ammonium or a univalent metal—such as sodium or potassium—and of a trivalent metal, such as aluminum, iron, or chromium). The chemical, in short, is an astringent and, as such, may be safely handled without gloves (although we do recommend keeping its dust out of your lungs and away from your mucous membranes). Do bear in mind, however, that aluminum sulfate is highly corrosive to most metals ... and, for this reason, an equal weight of ordinary lime (which neutralizes the alum) should be substituted for half the aluminum sulfate when your treated insulation will be used in metal buildings or mobile homes.

THE PRICE IS RIGHT

As the first chart reproduced here indicates, MOTHER's researchers ground up and tested six batches of cellulose fiber ... each of which contained a different percentage of vermin repellent and fireproofing. After trying to ignite all the test mixes with a propane torch and observing the results (see chart), we recommend that a minimum of 25 pounds of aluminum sulfate (or half aluminum sulfate and half lime) and 12 pounds of borax be mixed into every 100 pounds of ground newsprint or cardboard.

This figures out to a total chemical cost (at $8.50/100 pounds for aluminum sulfate and $15.00/100 pounds for borax) of less than $4.00 per 100 pounds of paper that is treated ... or 5¢ a square foot when an attic is filled with a 6"-deep layer of the cel-

lulose fiber (which produces a total "R" factor of 24, and that's very good). This compares quite favorably to the 24-1/2¢ a square foot that a local contractor charges to fill an attic space with only 5" of a commercially manufactured cellulose fiber. On a 1,300-square-foot house, that's an immediate saving of $253.50 right there ... and you're getting one-fifth more insulation to boot!

The chemicals were mixed into our first six test batches by shaking them onto the paper as it was fed into our hammermill. This is exactly the method used by the commercial manufacturers of cellulose fiber insulation that we've visited ... but it does have a minor drawback: The chemicals do tend to settle out of the mix as it's handled and, if some care isn't taken, more of the fire retardant than we like to see will wind up at the bottom of any space filled with this insulation.

For this reason we tried grinding some cellulose all by itself, putting it in a pile, and then sprinkling controlled amounts of borax and aluminum sulfate across the surfaces of the fiber. We were figuring, of course, that—since flames burn *up*—it would take less of the chemicals to fireproof the pulverized insulation if those chemicals were put on *top* of the cellulose, instead of being allowed to sift to its bottom.

The idea seems to have merit and our propane torch tests indicate that approximately another one cent in chemical costs can be shaved off every square foot of 6"-thick attic insulation with no reduction in fireproofing value when this method of distributing the borax and aluminum sulfate is used. That increases the saving on the cellulose fiber's installation cost for 1,300-square-foot house from $253.50 to $266.50. Not a great additional saving, to be sure, but one that you should know about.

INSTALLATION

MOTHER's homemade cellulose proved just as easy—no more and no less—to install as its commercially available counterpart. It's extremely easy to pour and spread around between the joists and other structures of an attic. And it's just as easy to add even more later, anytime you wish.

Putting the insulation into walls and other closed spaces is somewhat more difficult. This usually requires that a series of holes be drilled through a house's exterior siding (or that some of the siding actually be removed) so the material can be forced into the cavities with an insulation blower. Building supply stores sometimes have these blowers for rent ... and some clever do-it-yourselfers have actually forced their cellulose into walls with a hose attached to the exhaust end of a heavy-duty vacuum cleaner.

One final point: Any cellulose insulation—whether of the store-bought or I-made-it-myself variety—will absorb moisture when exposed to dampness of any kind. This, of course, reduces the material's "R" value ... and cellulose fibers should be used to insulate *only* those attics, walls, crawl spaces, etc., that you know will remain dry. ≏

OTHER researchers grind those papers ... the finished pro-   ... main fire test in process ... and fire test of "sprinkled" cellulose.

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IGNITION INHIBITORS FOR CELLULOSIC MATERIALS*

ABSTRACT: By exposing samples to various irradiance levels from a cali-
brated thermal radiation source, the ignition responses of blackened alpha-
cellulose and cotton cloth with and without fire-retardant additives were
compared. Samples treated with retardant compounds which showed the
most promise were then isothermally pyrolyzed in air so that comparisons
between the pyrolysis rates of the samples could be obtained. This was
done to gain further insight into the mechanisms of ignition and degrada-
tion in attempts to arrive at a better understanding of flammability.

Alpha-cellulose samples containing a mixture of boric acid, borax and
ammonium di-hydrogen phosphate could not be ignited by irradiances up
to 4.0 cal cm^{-2} sec-1 (16.7 W/cm^2). At higher irradiances the specimens
ignited, but flaming lasted only until the flammable gases were depleted.
Cotton cloth containing a polymeric retardant with the designation THPC
+ MM was found to be ignition-resistant to all irradiances below 7.0 cal
cm^{-2} sec^{-1} (29.3 W/cm^2). Comparison of the pyrolysis rates of the retar-
dant-treated alpha-cellulose and the retardant-treated cotton showed that
the retardant (mechanism) is qualitatively the same.

Similar ignition-response measurements were also made with specimens
exposed to ionizing radiation. We observed the gamma radiation results in
ignition retardance of cellulose, while irradiation by neutrons does not.

INTRODUCTION

THERMAL HARDENING PROCEDURES are, by definition, "passive counter-meas-
ures" employed to reduce the fire losses of property and lives [1]. Ignition of
cellulosic materials by thermal radiation from fires is one of the primary mecha-
nisms for fire spread. Thus, ignition counter-measures should be a primary consider-
ation for thermal-hardening research.

The most desirable ignition-inhibiting technique is to treat the cellulosic material
by some as yet unknown method to render it permanently non-flammable, while, at

the same time, not appreciably ch
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fire spread in cellulosic materials
modification of the molecular str
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The goals of these experimental

- Test the effectiveness of "w
- Ascertain what class of chem
- Modify the molecular stru
  non-chemical methods, and
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IGNIT

The cellulosic material used fo
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cellulose was blackened by 2.5%
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and dried along with the treated
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Table 1 lists the retardant salts,
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PYRO

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the same time, not appreciably changing its normal physical characteristics. Chemical fire-retardants have been developed which have the ability to effectively prevent fire spread in cellulosic materials [2–4]. The fire retardance is accomplished by modification of the molecular structure during pyrolysis to produce a reduction in the fraction of flammable gases and tars [5]. It is probable that these chemicals will inhibit ignition in a similar manner.

The goals of these experimentals were to:

- Test the effectiveness of "well known" fire retardants as ignition inhibitors;
- Ascertain what class of chemical inhibitor is most effective in this respect;
- Modify the molecular structure of the experimental cellulosic material by non-chemical methods, and observe the effect of this treatment on the ignition response.

IGNITION EXPERIMENTS

The cellulosic material used for most of the measurements was black alpha-cellulose, 0.5 mm (0.020-in.) thick and roughly 50 X 75 mm (2 X 3 inches) in size. The cellulose was blackened by 2.5% carbon black during its manufacture so that it has a uniformly high absorptivity during exposure to thermal radiation pulses. A number of samples were soaked in the respective retardant solutions, then pressed between clean paper towels to remove excess liquid, and finally air-dried. The difference between the pre- and post-treatment weight of the samples was an effective measure of the retardant loading. Control samples were soaked in distilled water and dried along with the treated specimens. When controls had returned to their original weight, the treated specimens were ready for exposure to an ignition source. Table 1 lists the retardant salts, solution concentrations, and average dry-weight retardant loading in the cellulose samples.

The thermal radiation source used for these measurements was a 6- by 7.5-cm array of tungsten-halogen high-intensity lamps [6]. The technique of measurement was to place the sample on an adjustable table parallel to the source bank, expose the sample to a calibrated squarewave pulse of radiant energy, and then determine the time to sample ignition. As the distance from the source increases, the irradiance is reduced. Thus, both the flaming- and glowing-ignition thresholds at various irradiance levels can be easily and accurately measured [7].

PYROLYSIS EXPERIMENTS

To determine the relative retardance between the additives, we examined the rate of pyrolysis of the specimens in air. These measurements were made by placing the specimens in a highly stabilized furnace set at $315° \pm 5°C$ for a predetermined period of time, and then measuring the relative weight loss with a sensitive torsion balance. This procedure was repeated for increasing periods of time until the

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Table 1. Retardants and their loads in the tested materials.

	Retardant	Solution concentration (%)	Resultant load (%)
1.	KHCO$_3$	10	11.9
2.	KHCO$_3$	2	2.72
3.	Borax-boric acid*	10	12.7
4.	Borax-boric acid*	2	2.76
5.	Borax-boric acid*	0.2	0.29
6.	AlCl$_3$·6H$_2$O	2	2.77
7.	(NH$_4$)H$_2$PO$_4$	2	2.74
8.	B.B.P.§	10	12.7
9.	AlCl$_3$·6H$_2$O[†]	2	2.77[††]
10.	THPC + mm♦	—	24.4

*A mixture of 7% borax and 3% boric acid (N.F.P.A. Handbook, Retardant Formula Number 2).

§A mixture of 3.5% borax, 1.5% boric acid, and 5% (NH$_4$)H$_2$PO$_4$.

[†]Held at 180°C for 1 hr to produce insoluble Al$_2$O$_3$ and HCl ↑. Washed after cooling to leach out residual HCl.

♦Developed by the Department of Agriculture to retard flaming in cotton cloth. THPC + mm = tetrakis (hydroxymethyl) phosphonium chloride + methylolmelamine.

[††]Pre-heat treatment loading.

samples ignited to a glowing combustion, or no further weight loss was observed.

Measurements were made of the ignition response and pyrolysis rate of untreated cotton cloth, and cotton cloth treated with polymeric fire retardants developed by the Department of Agriculture at New Orleans [4]. The untreated cloth was the same thickness and weight as the treated cloth. However, it had been previously purchased for other ignition work. The main difference between these specimens was the color and the retardant treatment. The treated cloth was dark green, while the untreated cloth was black.

EXPERIMENTAL PROCEDURE

The retardants chosen for ignition studies are shown in Table 1. These are: (1) a mixture of borax and boric acid (B.B.A.); (2) potassium bicarbonate (KHCO$_3$); (3) ammonium di-hydrogen phosphate (NH$_4$) H$_2$PO$_4$, and (4) hydrated aluminum chloride (AlCl$_3$ + 6H$_2$O).

Table 1 also lists three synthesized retardant treatments which were subjected not only to ignition measurements, but also to air-pyrolysis measurements. The solution of 3.5% boric acid and 5% (NH$_4$)H$_2$PO$_4$ (B.B.P.) was made with the hopes

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that the combination of good fla
a good "all around" inhibitor. A
the 2.0% solution of AlCl·6H$_2$O
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hat the combination of good flaming and glowing ignition inhibitors may produce
a good "all around" inhibitor. Another process was to hold samples treated with
the 2.0% solution of $AlCl \cdot 6H_2O$ at $180^\circ C$ for several hours so that the conversion
of $AlCl_3 \cdot 6H_2O$ to insoluble $Al_2O_3 + HCl$ gas could occur. This procedure was
suggested by Parker [1] who stated that fire retardance in treated cellulose may be
a result of a catalytic action by the oxygen-bearing retardants, causing greater
conversion of pyrolysis products to char. Further, the acidic or basic characteristics
of the retardant salts serve simply to increase the rate of molecular scissions, thus
increasing the pyrolysis rate. Removal of HCl by the above treatment could reduce
the [increase in] the pyrolysis rate and yet impart fire retardance.

The last retardant listed in Table 1, THPC + MM, was selected from a variety of
retardant-treated cotton cloths supplied by the Department of Agriculture South-
ern Regional Laboratory. The basis of selection was governed by determining which
of the retardant-treated material took the longest to ignite when exposed to a
constant thermal flux. All of the treated cotton samples were found to be quite
flame resistant; however, the THPC + MM-treated cotton with highest retardant
loading had the greatest resistance to ignition. This material also is a phosphorus-
containing polymer which is of interest because of its glow-retarding properties.

RESULTS

The ignition response of the retardant-treated samples, compared to the ignition
response of the control, are, shown in Fig. 1 in conjunction with the identification
code of Table 1.* The pyrolysis data are presented in Fig. 2.

Figure 1 shows that most of the additives reduce the susceptibility of the tested
cellulosic materials to flaming ignition, depending on the amount of additive ab-
sorbed in the material. Many of these retardants increased the susceptibility of the
materials to glowing ignition.

Figure 2 shows that the pyrolysis rate increases in all the treated specimens. In
most cases, a large quantity of vapor is initially evolved after which the visible
evolution of gas is either non-existent or minimal. The gases of this evolution are
readily ignitable with a hot wire pilot source placed in the flow. Only cellulose
treated with 2.0% $(NH_4)H_2PO_4$ survives the exposure intact in the form of a brittle
char, which vaguely resembles the original specimens. The other samples, if they
were ignited, are completely consumed by glowing combustion.

Note that the addition of an inert blackening agent, such as carbon black, has no
effect upon the rate of thermal degradation. Also interesting is the fact that the
pyrolyses of untreated alpha-cellulose and cotton cloth are quite similar. It is im-
possible to measure weight loss of both black and white untreated cellulose after 5
min. at the testing temperature since all of the samples glow beyond this point. The
abrupt change in the shape of the weight regression curve past 4 min. indicates a
region of faster pyrolysis which just precedes the onset of glowing combustion.

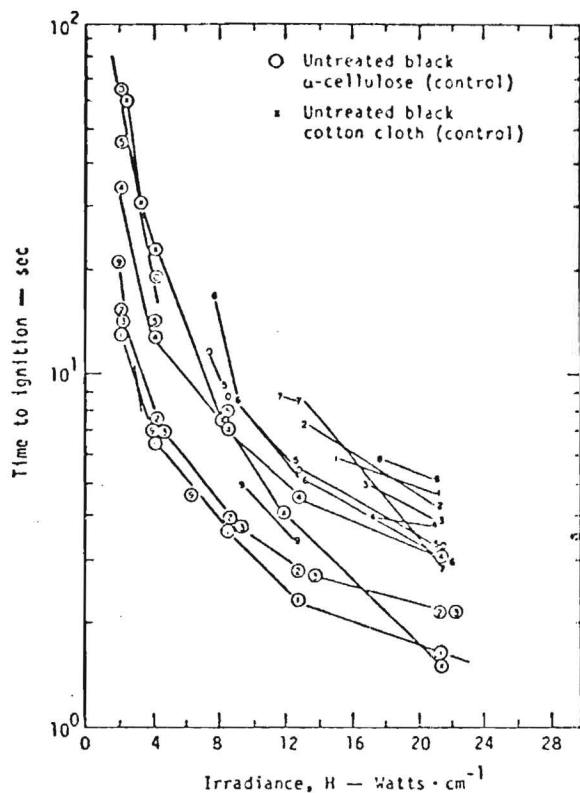*The heading numbers are the identification sequence.

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Figure 1. Ignition in air. Numbers refer to identification of retardants listed in Table 1. Uncircled numbers refer to flaming points; circled numbers refer to glowing points.
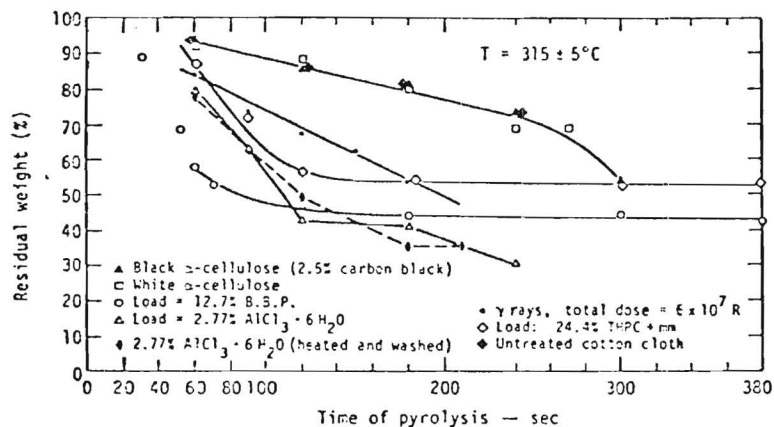

Figure 2. Pyrolysis of α-cellulose

The following conclusions sum

- As a general rule, good co
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- A mixture of 10% B.B.P. m
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- The additives developed b
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- At irradiances intense enou
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- The gases initially expell
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- Retardant compounds con
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- There is evidence which s
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1. W. J. Parker, *Thermal Hardening*
   TR-984 24 Feb. 1966.
2. G. H. Trylon, Fire Protection H.
   Boston, 1962.
3. R. W. Little, *Flame Proofing Tex*
   104, Reinhold, New York, 1947.
4. R. M. Perkins, G. L. Drake, Jr. and
5. W. K. Tang and W. K. Neill, *J. Poly*
6. R. J. Jenkins, *Calorimeters and R*
   ances, USNRDL-TR-839, 5 April
7. S. B. Martin and N. J. Alvares,
   USNRDL-TR-1007, 11 April 1966

CONCLUSIONS

The following conclusions summarize the work reported here:

- As a general rule, good combustion retardants are also good ignition inhibitors.
- A mixture of 10% B.B.P. makes an excellent temporary additive for inhibiting ignition.
- The additives developed by the Department of Agriculture for cotton cloth are excellent, semi-permanent retardants for ignition by thermal radiation.
- At irradiances intense enough to ignite cellulosics treated with the B.B.P. or the THPC + MM retardants described here, only transient flaming ignition will occur. Furthermore, flaming will last only until pyrolysis is complete, leaving an inert residual char. Since the duration of flaming combustion is short, the opportunity for the spread of fire is greatly reduced.
- The gases initially expelled from pyrolyzing retardant-treated cellulose are, generally, ignitable.
- Retardant compounds containing phosphorus appear to be more successful in preventing afterglow than those that do not contain phosphorus.
- There is evidence which shows that ionizing radiation does afford ignition protection to cellulosic materials by some process which has not been defined.

REFERENCES

1. W. J. Parker, *Thermal Hardening Considerations Pertaining to Residential Areas*, USNRDL-TR-984 24 Feb. 1966.
2. G. H. Trylon, Fire Protection Handbook, 13th Ed., National Fire Protection Association, Boston, 1962.
3. R. W. Little, *Flame Proofing Textile Fabrics*, American Chemistry Society Monograph No. 104, Reinhold, New York, 1947.
4. R. M. Perkins, G. L. Drake, Jr. and W. A. Reeves, *J. Appl. Polym. Sci. 10*, (1966).
5. W. K. Tang and W. K. Neill, *J. Polym. Sci. 6*, 1964.
6. R. J. Jenkins, *Calorimeters and Radiometers for the Measurement of Large Thermal Irradiances*, USNRDL-TR-839, 6 April 1965.
7. S. B. Martin and N. J. Alvares, *Ignition Thresholds for Large-Yield Nuclear Weapons*, USNRDL-TR-1007, 11 April 1966.

NOTICE

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FLASH-FIRE PROPENSITY OF CELLULOSE INSULATION SAMPLES CONTAINING VARIOUS BORATE FIRE RETARDANTS

ABSTRACT: Various samples of cellulose insulation were evaluated for flash-fire propensity, using the test method developed at the University of San Francisco. The samples included untreated cellulose insulation and insulation treated with various levels of 5-mol borax, boric acid, and mixtures of boric acid and 5-mol borax.

All the treatments reduced the flame height, but there were no statistically significant differences between the treatment types. Boric acid reduced the weight loss on pyrolysis more than the other treatments.

INTRODUCTION

CELLULOSE INSULATION IS widely used as insulation for existing and new homes and industrial buildings as part of efforts toward energy conservation. Because the cellulose insulation is combustible without treatment, is divided into pieces with high surface areas, and exposed in attics and crawl spaces, fire safety is an important consideration.

Flash fires are a special form of fire hazard which combine the different aspects of ignitability, flammability, heat release, and flame spread. A flash fire has been defined (1) as a fire (flame front) which propagates through a fuel-air mixture as a result of the energy release from the combustion of that fuel, having required only an ignition source.

It should be emphasized that a flash fire is not the same as flashover. Flashover has been defined (2) as a stage in the development of a contained fire in which all

exposed surfaces reach ignit
spreads throughout the space

Flash fires occur when c
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contact with a source of igni

A simple laboratory met
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$Na_2B_8O_7 \cdot 10H_2O$.

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The results are tabulate
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Figure 2); therefore it is
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exposed surfaces reach ignition temperature more or less simultaneously and fire spreads throughout the space and flames appear on all surfaces.

Flash fires occur when combustible vapors are evolved from pyrolyzing or burning materials, escape burning at the site of the parent materials, and accumulate as substantial volumes of combustible-air mixtures; these mixtures then come into contact with a source of ignition.

A simple laboratory method was developed at the University of San Francisco for evaluating the flash fire propensity of materials [3, 4]. This paper presents the results of evaluating various cellulose insulation samples by means of this test method.

MATERIALS

A standard sample of cellulose insulation was prepared by hammer milling a mixture of the Los Angeles Times, the Wall Street Journal, and Santa Ana Register, and mixing the milled cellulose with air to produce an insulation material with a bulk density on the order of 2 lbs/ft^3. Only the newsprint portions of the newspapers were used.

Cellulose insulation samples with different levels of various borate-containing fire retardants were prepared by mixing known amounts of the powdered fire retardant with the cellulose material in a cyclone mixer; the concentration of the fire retardant was confirmed by chemical analysis.

Three fire retardants were used: boric acid, 5-mol borax, and a 46/54 mixture of boric acid and 5-mol borax. The highest concentrations used were approximately 36 percent of fire retardant by weight. 5-Mol borax has the chemical formula $Na_2B_4O_7 \cdot 5H_2O$, whereas the common, 10-mol borax has the formula $Na_2B_3O_7 \cdot 10H_2O$.

METHOD

The apparatus and procedure have been described in earlier papers [3, 4] (Figure 1).

A 0.10 g sample of cellulose insulation was used in each test. The pyrolysis temperature was 800°C.

RESULTS

The results are tabulated in Table 1 as average values ± one standard deviation.

Straight lines were fitted to the data for flame height versus weight percent add on by the method of least squares; lines fitted to the individual treatments are shown dotted in Figure 2. An "F" ratio test showed no significant increase in residual variance if the data were all fitted to a single line (shown as a solid line in Figure 2); therefore it is concluded that these data cannot distinguish any differences in flame height performance among the different treatments.

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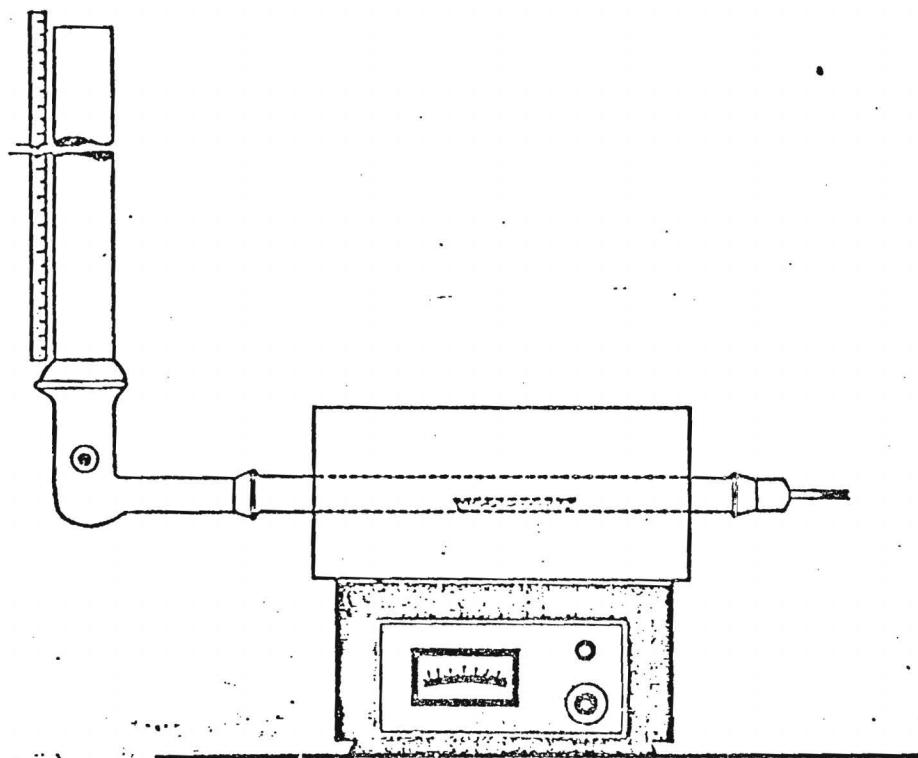
Figure 1. USF flash-fire apparatus.

The equation relating flame height to weight percent add on is:

$$\text{Flame height} = 21.0 - 0.415 \text{ (wt \% add on)}$$

An attempt to relate the time to flash fire with weight percent add on showed no statistically significant correlation between these variables.

Straight lines were fitted to the data for weight loss on pyrolysis versus weight percent add on. It was found that there is a statistically significant difference between the behavior of boric acid and 5-mol borax, but there is no difference in the behavior of 5-mol borax and the 46/54 mixture of boric acid and 5-mol borax. The equations fitted are:

$$\text{\% wt loss} = 93.52 - 0.922 \text{ (wt \% add on)}$$
for boric acid, and

$$\text{\% wt loss} = 94.92 - 0.657 \text{ (wt \% add on)}$$
for 5-mol borax or the mixture

Table 1. Flash-Fire Propensity of Cellulose Insulation Without and With Boron Fire Retardants.

cellulose insulation	flash fire height, in	time, sec, to flash fire	weight loss per cent
untreated	21.7 + 2.6	18.4 + 2.9	98.3 + 1.6

Table 1. Flash-Fire Propensity of Cellulose Insulation Without and With Boron Fire Retardants.

cellulose insulation	flash fire height, in	time, sec, to flash fire	weight loss per cent
untreated	21.7 ± 2.6	18.4 ± 2.9	98.3 ± 1.6
containing boric acid			
5.3%	16.2 + 7.8	19.1 + 4.4	83.5 + 0.1
15.8%	11.5 ± 0.5	14.0 ± 1.2	77.2 ± 1.1
26.0%	8.0 ± 3.5	14.0 ± 1.3	72.1 ± 2.5
36.7%	1.2 ± 0.4	17.6 ± 0.8	59.1 ± 4.0
containing 5 mol borax			
7.7%	19.3 + 5.4	19.7 + 5.4	91.0 + 0.4
14.0%	9.7 ± 4.2	14.9 ± 1.4	86.1 ± 0.7
21.3%	15.7 ± 5.8	17.1 + 3.1	80.5 + 0.5
36.3%	5.8 ± 1.9	20.1 ± 2.5	73.2 ± 1.0
containing 46/54 BA/5MB mixture			
5.5%	22.8 + 1.9	18.5 + 3.0	89.1 + 0.4
14.8%	11.2 ± 4.5	17.9 ± 4.7	83.6 ± 1.5
25.2%	13.7 ± 2.8	21.4 ± 1.3	76.0 + 0.8
35.6%	10.5 ± 4.4	18.2 ± 3.4	72.6 ± 1.0

Figure 2. Effect of additives.

Table 2. Comparison of Pred...

Material			
Boric Acid			
5-Mol Borax			
46/54 Mixture			

One would expect to se
difference in the flame he
present data may be due to
An alternative explanation i
products to produce volatil
height is not significantly alt

As indicated in the table
prior results for other cellula

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Cellulosic insulation pres
propensity. Results for thi
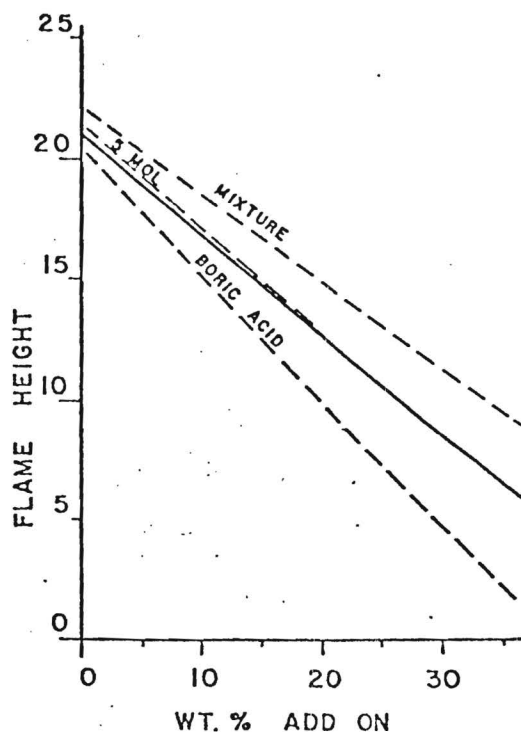cellulosic materials.

DISCUSSION

As a starting point, it could be assumed that the chemical additives act as diluents for the weight loss on pyrolysis without affecting the pyrolysis mechanism. If this were the case the weight loss should be the sum of that due to untreated cellulose plus the dehydration of the chemical additive.

Table 2 compares the predicted weight loss calculated in this manner with the observed weight loss (from the fitted line) at 35% add on. There is no statistically significant difference between the predicted and observed weight losses for 5-mol borax or the 46/54 mixture of 5-mol borax and boric acid. However, the observed weight loss for boric acid is significantly less than the predicted value. As a consequence, it appears that boric acid is affecting the pyrolysis of the cellulose to produce a lower weight loss. 5-Mol borax does not affect the pyrolysis of the cellulose, and when present at approximately equal weight with boric acid it appears to stop the action of the boric acid on the pyrolysis. This result may be due to a reaction between the borax and boric acid to produce sodium pentaborate, $Na_2O \; 5B_2O_3 \cdot 10H_2O$.

1. J. E. Brown and J. J. Come...
   of Polymeric Materials," N
   (December 1975).
2. B. W. Kuvshinoff, R. M. Frist
   John Wiley and Sons, New Y
3. C. J. Hilado and H. J. Cum...
   Propensity of Materials," J...
   1977).
4. C. J. Hilado and H. J. Cum...
   Flammability, Vol. 8, No. 4,

Table 2. Comparison of Predicted and Observed Weight Loss at 35% Add On.

Material	Predicted Loss	Observed Loss
Boric Acid	76.1	61.3
5-Mol Borax	73.2	71.9
46/54 Mixture	74.3	71.9

One would expect to see the effect of boric acid on pyrolysis reflected in a difference in the flame height. That such a difference is not borne out by the present data may be due to the experimental variability in the flame height data. An alternative explanation is that the boric acid alters the nature of the pyrolysis products to produce volatiles with different flammability limits so that the flame height is not significantly altered.

As indicated in the table below, the results for flame height are consistent with prior results for other cellulosic materials.

Hardwoods	20–26
Softwoods	23–26
Sisal	23
Cotton fabrics	18–24
Kapok	13
Cotton batting	14

CONCLUSIONS

Cellulosic insulation presents no special hazard from the standpoint of flash fire propensity. Results for this material are consistent with those observed for other cellulosic materials.

REFERENCES

1. J. E. Brown and J. J. Comeford, "A Technique for the Measurement of Flash-Fire Potential of Polymeric Materials," NBSIR 75-757, National Bureau of Standards, Washington, DC (December 1975).
2. B. W. Kuvshinoff, R. M. Fristrom, G. L. Ordway and R. L. Tuve, "Fire Sciences Dictionary," John Wiley and Sons, New York (1977).
3. C. J. Hilado and H. J. Cumming, "A Simple Laboratory Method for Determining Flash-Fire Propensity of Materials," Journal of Fire and Flammability, Vol. 8, No. 3, 332–348 (July 1977).
4. C. J. Hilado and H. J. Cumming, "Flash Fire Propensity of Materials," Journal of Fire and Flammability, Vol. 8, No. 4, 443–457 (October 1977).

APPENDIX C

BORIC ACID

THEORETICAL COMPOSITION

Boric Oxide (B_2O_3) 56.30%
Water (H_2O) 43.70

PHYSICAL and CHEMICAL PROPERTIES

Formula Weight 61.83
Specific Gravity 1.5128
Heat of Solution @ 18°C (64°F)
                          BTU per pound (absorbed) 157
Melting Point (heated in closed space)
                          170.9°C ± 0.2°C (340°F)

NOTE: When heated above 100°C (212°F) in the open, it gradually loses water, first changing to Metaboric Acid, HBO_2, of which three monotropic forms exist. These have melting points, respectively, of 176°C (349°F); 201°C (392°F); and 236°C and (457°F). Dehydration stops at the composition HBO_2 unless the time of heating is extended or the temperature raised above 150°C (292°F). On continued heating and higher temperatures, all water is removed leaving the anhydrous oxide, B_2O_3, the crystalline form of which melts at 450°C (842°F). The amorphous form has no definite melting point, softening at about 325°C (617°F) and becoming fully fluid at about 500°C (932°F).

STABILITY: BORIC ACID is stable at ordinary temperatures. It is volatile in steam without decomposition.

HYDROGEN ION CONCENTRATION: Aqueous solutions of BORIC ACID are acidic, the pH decreasing with increasing concentration.

% H_3BO_3 by weight of solution	pH @ 20°C (68°F)	% H_3BO_3 by weight of solution	pH @ 20°C (68°F)
0.1%	6.1	2.0%	4.5
0.5	5.6	3.0	4.2
1.0	5.1	4.0	3.9
		4.72 (saturated @ 20°C)	3.7

BORIC ACID

SOLUBILITY IN WATER

Temperature			Parts H₃BO₃ per 100 Parts	Pounds Boric Acid per U.S.
°C	°F	Wt. % H₃BO₃	H₂O by Weight	Gallon of Water
0.0	32.0	2.52	2.59	0.216 (3.5 oz.)
5.0	41.0	2.98	3.07	0.256 (4.1 oz.)
10.0	50.0	3.49	3.62	0.302 (4.8 oz.)
15.0	59.0	4.08	4.25	0.355 (5.7 oz.)
20.0	68.0	4.72	4.95	0.413 (6.6 oz.)
25.0	77.0	5.46	5.78	0.481 (7.7 oz.)
30.0	86.0	6.23	6.64	0.552 (8.8 oz.)
35.0	95.0	7.12	7.67	0.636 (10.2 oz.)
40.0	104.0	8.08	8.79	0.728 (11.6 oz.)
45.0	113.0	9.12	10.02	0.830 (13.3 oz.)
50.0	122.0	10.27	11.45	0.944 (15.1 oz.)
55.0	131.0	11.55	13.06	1.074
60.0	140.0	12.97	14.90	1.223
65.0	149.0	14.42	16.85	1.379
70.0	158.0	15.75	18.69	1.526
75.0	167.0	17.41	21.08	1.715
80.0	176.0	19.10	23.61	1.914
85.0	185.0	21.01	26.60	2.151
90.0	194.0	23.27	30.33	2.444
95.0	203.0	25.22	33.73	2.707
100.0	212.0	27.53	37.99	3.039
103.3	217.9	29.27	41.38	3.301

NOTE: The solubility of BORIC ACID in water is influenced by the presence of certain other substances. Sodium chloride, lithium chloride and mineral acids decrease the solubility. Potassium nitrate, sulfate and chloride, and sodium nitrate and sulfate increase the solubility. Borax raises the solubility of BORIC ACID due to formation of sodium polyborates, Refer to Table on page 48 and Chart on page 47.

SOLUBILITY IN SOME ORGANIC SOLVENTS

Glycerol (98.5%)	@ 20°C (68°F) % by wt. of solution	19.9% H₃BO₃		
Glycerol (86.5%)	@ 20°C	21.1%	"	
Ethylene Glycol	@ 25°C (77°F)	18.5%	"	
Di-Ethylene Glycol	@ 25°C	13.6%	"	
Ethyl Acetate	@ 25°C	1.5%	"	
Acetone	@ 25°C	.6%	"	
Glacial Acetic Acid	@ 30°C (86°F)	6.3%	"	
Ethyl Alcohol	@ 25°C	grams per liter 94.4 gms. H₃BO₃		
Methyl Alcohol	@ 25°C	179.3	"	"
n-Propyl Alcohol	@ 25°C	59.4	"	"
i-Butyl Alcohol	@ 25°C	42.8	"	"
i-Amyl Alcohol	@ 25°C	35.3	"	"

INDUSTRIAL USES include:

Ceramics	Cosmetics	Leather finishing
Glazes and Colors	Dye stabilizer	compounds
Salt Glazing	Electroplating (nickel)	Deliming hides
Chemicals Manufacturing	Electrolytic condensers	and skins
Boron Fluorides,	Enamels	Paints, latex base*
Fluoborates, Borides,	Flameproofing	Pharmaceuticals
Boron alloys, Boron	Fluxes; welding and	Sand-casting
Carbide, Ferro-Boron	brazing	magnesium alloys
Citrus Fruit Wash	Glass; optical, fiber,	Textile finishing
Blue and Green	borosilicate	compounds
Mould Inhibitor	Insecticides	Wood preservative

*See MC-15 FR28®
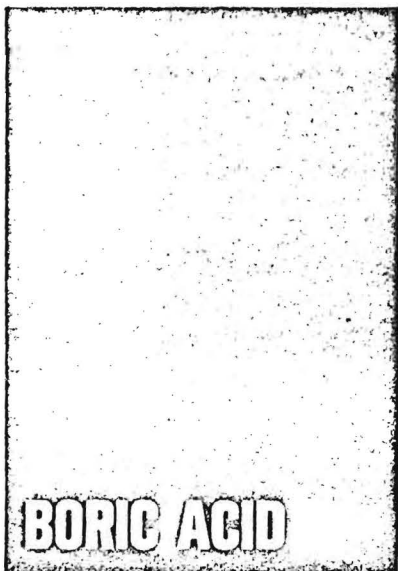
BORIC ACID

TECHNICAL, N.F. GRADES

Technical and N.F. Grades of Boric Acid, H_3BO_3 are available in the following forms:

**GRANULAR, POWDERED AND IMPALPABLE.**

TYPICAL ANALYSIS

CHEMICAL		Technical	N.F.
Boric Oxide (B_2O_3)	. . . . . .	56.5%	56.4%
Water (H_2O by difference)	. . . . .	43.5	43.6
Boric Acid (H_3BO_3)	. . . .	100.3	100.1

IMPURITIES		Technical		
		Maximum	Typical	N.F. *
Chloride (Cl)	. . . .	0.01%	0.0006%	
Sulfate (SO_4)	. . . . . .	0.10	0.03	
Iron Oxide (Fe_2O_3)	. . . .	0.0007	0.0003	

*N.F. Grade conforms to all standards of the National Formulary, Edition XIII

SCREEN SPECIFICATIONS / AVG. BULK DENSITY

Mesh Designation	U.S. Standard	Sieve No.	Pounds per Cubic Foot Loose Pack	Tight Pack
Granular	+8	0% Max.	55	58
Powdered	+200	10% Max.	37	48
Impalpable	+200	3% Max.	37	47

AVG. PARTICLE SIZE DISTRIBUTION
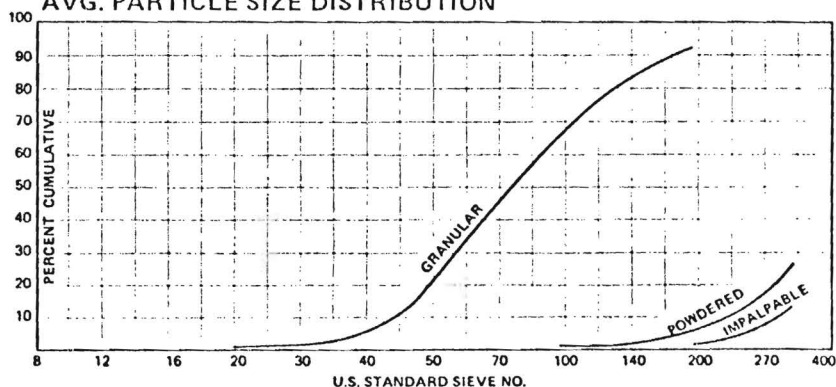
CONTAINERS

Multiwall paper bags with a polyethylene free film moisture-resistant barrier, 100 pounds net; or fiber drums with polyethylene liner, net weight as follows: Granular, 300 lbs., Powder, 250 lbs. Impalpable Powder, 225 lbs. Powder, 225 lbs.

BORAX

THEORETICAL COMPOSITION

Sodium Oxide (Na_2O) 16.25%
Boric Oxide (B_2O_3) 36.51
Water of Crystallization (H_2O) 47.24
Anhydrous Borax ($Na_2B_4O_7$) 52.76

PHYSICAL and CHEMICAL PROPERTIES

Formula Weight 381.37
Specific Gravity 1.73
Melting Point—Heated in closed space, begins
                to melt in own water at about . . . . 62°C (144°F)
Melting Point (Anhydrous Form) . . . . 742°C ±1° (1367°F)
Heat of Solution—BTU per pound (absorbed) . . . . —122

Dissolved in water, BORAX hydrolyzes to give a mildly alkaline solution. It is thus capable of neutralizing acids. It also combines with strong alkalies to form compounds of lower pH.

STABILITY: Sodium Tetraborate Decahydrate is stable under ordinary conditions but exposed to dry air or elevated temperatures it tends to lose water of crystallization. The basic chemical composition or properties are not changed thereby. When heated above 144°F BORAX melts in its own water, swells to a frothy mass, and when fully dehydrated at increasing temperatures it fuses to a clear glass.

HYDROGEN ION CONCENTRATION: The pH of a 0.1 molar solution of BORAX, about 3%, at 20°C (68°F) is 9.25. The value increases very slightly with increasing concentration, and diminishes very slightly with increasing temperature. This relatively constant pH of BORAX solutions makes it an excellent buffering agent. (See chart on page 55 "pH Values of Borate Solutions.")

COMPARATIVE pH OF SOLUTIONS
OF SOME COMMON ALKALIES @ 20°C (68°F)

Concentration, weight percent	0.1%	0.5%	1.0%	2.0%	5.0%
Caustic Soda $NaOH$	11.90	12.70	13.10	13.30	13.80
Sodium Metasilicate Na_2SiO_3	11.30	12.10	12.30	12.70	13.10
Trisodium Phosphate $Na_3PO_4 \cdot 12H_2O$	11.50	11.55	11.60	11.70	11.80
Soda Ash Na_2CO_3	10.70	11.30	11.40	11.50	11.60
Sodium Metaborate $Na_2B_2O_4 \cdot 8H_2O$	10.52	10.84	11.00	11.18	11.44
Borax $Na_2B_4O_7 \cdot 10H_2O$	9.26	9.23	9.24	9.24	(9.32*)

*pH @ 4.71% Borax, saturated solution at 20° (68°F).

BORAX

SOLUBILITY IN WATER, as $Na_2B_4O_7 \cdot 10H_2O$

Temperature		Parts Borax per 100 parts water by weight	Percent Borax by weight of saturated solution	Pounds of Borax per U.S. gallon of water
°C	°F			
0	32	2.03	1.99	0.170 (2.7 oz.)
5	41	2.53	2.47	0.211 (3.4 oz.)
10	50	3.18	3.08	0.265 (4.2 oz.)
15	59	3.94	3.79	0.328 (5.2 oz.)
20	68	4.94	4.71	0.412 (6.6 oz.)
25	77	6.17	5.81	0.513 (8.2 oz.)
30	86	7.76	7.20	0.645 (10.3 oz.)
35	95	9.91	9.02	0.822 (13.2 oz.)
40	104	12.65	11.22	1.047
45	113	16.56	14.21	1.37
50	122	21.82	17.91	1.80
55	131	30.23	23.21	2.49
58.5	137.3*	37.97	27.52	3.12
60	140	43.51	30.32	3.57
60.8	141.4**	46.09	31.55	3.78
65	149	51.24	33.88	4.19
70	158	58.58	36.94	4.78
75	167	67.17	40.18	5.46
80	176	79.57	44.31	6.45
85	185	94.3	48.53	7.62
90	194	113.6	53.18	9.15
95	203	143.5	58.93	11.52
100	212	191.0	65.63	15.27
102.8	217 ***	229.1	69.61	18.28

*Transition point to Kernite ($Na_2B_4O_7 \cdot 4 H_2O$)
**Transition point to 5 MOL Hydrate
***Boiling Point

SOLUBILITY IN OTHER SOLVENTS

		Percent Borax by weight
Glycerol (98.5%)	@ 20°C (68°F)	52.6%
Glycerol (86.5%)	@ 20°C	47.1
Ethylene Glycol	@ 25°C (77°F)	41.6
Di-Ethylene Glycol	@ 25°C	18.6
Methanol	@ 25°C	19.9
Aqueous Ethyl Alcohol (46.5% C_2H_5OH by volume)	@ 15.5°C (60°F)	2.48
Acetone	@ 25°C (77°F)	0.60
Ethyl Acetate	@ 25°C	0.14

Boric Acid increases the solubility of BORAX due to formation of poly-borates. Refer to chart and table on pages 47 and 48.
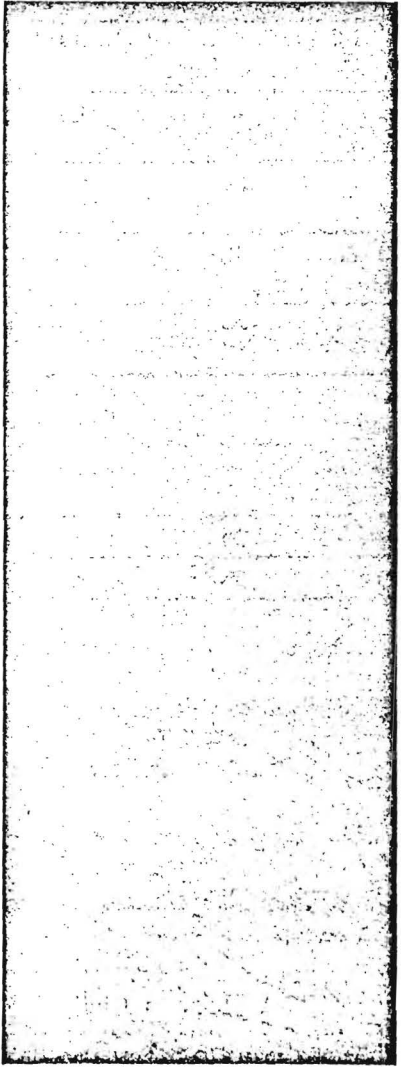
MISCELLANEOUS PROPERTIES: BORAX is a solvent for caseins, dextrines, shellac and certain natural gums; an excellent emulsifier for many oils and waxes. It protects ferrous metals against rusting, while the affinity of fused BORAX for metallic oxides renders it extremely useful as a flux in welding and brazing, metal refining, and the manufacture of glass and enamels. BORAX is a constituent of many fire retardant compositions. It supplies a trace element essential to proper plant growth; on the other hand, in large dosages it will eliminate unwanted vegetation.

BORAX

TECHNICAL GRADE

TYPICAL ANALYSIS

CHEMICAL	Granular	Powdered	Extra Fine
Sodium Oxide (Na_2O)	16.7%	17.1%	17.2%
Boric Oxide (B_2O_3)	36.5	38.4	38.6
Water of Crystallization			
(H_2O by difference)	45.8	44.5	44.2
Anhydrous Borax ($Na_2B_4O_7$) . . .	54.2	55.5	55.8
Equivalent Borax ($Na_2B_4O_7 \cdot 10H_2O$) .	99.5	105.2	105.7

	(all forms)	
IMPURITIES	Maximum	Typical
Chloride (Cl)	0.07	0.035
Sulfate (SO_4)	0.06	0.03
Iron Oxide (Fe_2O_3)	0.003	0.0014
Insoluble	0.02	

See next page for screen sizes and bulk densities.

CONTAINERS
Multiwall paper bags with a polyethylene free film moisture-resistant barrier, 100 pounds net, and fiber drums with polyethylene liner as follows: Granular—335 lbs. net. Powdered—300 lbs. net. Extra Fine—225 lbs. net.

INDUSTRIAL USES
Borax has many useful purposes in solutions and in fusions which result in wide and varied applications such as these:

|		
Preservation of straw, wood chips, bagasse and cellulosic materials	Paints, casein type	Photographic Developers
Adhesives—Dextrine and Starch types	Washing Compounds	Wax Polishes
Casein Solvent	Weed Control (Special Borates)	Cosmetics
Ceramics	Chemicals Manufacturing Perborates, Metal Borates	Glues
Pottery Glazes	Corrosion Inhibitor	Insecticides
Salt Glazing	Anti-Freeze Solutions	Laundry Starches
Enamels (Anhydrous Borax)	Ferrous Metals	Soaps
Heat-treating metals; salt baths	Leather Finishing Compounds	Paper Coatings and sizings
	Lumber Preservative	Water Softeners
		Wire Drawing

BORAX

TECHNICAL GRADE

AVAILABLE SCREEN SIZES AND BULK DENSITIES

Mesh Designation	U.S. Standard Sieve No.	Percent Cumulative	Pounds per Cubic Foot, Typical	
			Loose Pack	Tight Pack
Granular Borax	−8	100%	51	59
8/40	+8	None	46	53
	+40	90% Min.		
8/60	+8	None	48	54
	+60	85% Min		
30/70	+30	Trace	48	57
	+70	50% Min.		
30/200	+30	Trace	46	57
	+200	85% Min.		
40/100	+40	0.5% Max.	45	55
	+100	85% Min.		
40/140	+40	Trace	47	57
	+140	70% Min		
40/200	+40	Trace	46	57
	+200	85% Min		
60/200	+60	1% Max.	45	55
	+200	65% Min.		
Powdered	+70	8% Max.	38	56
Extra Fine	+100	1% Max.	35	56

*Trace indicates under 0.1%.

AVG. PARTICLE SIZE DISTRIBUTION
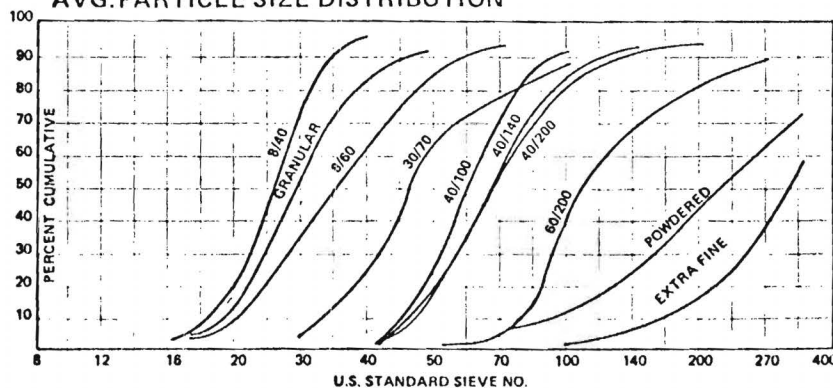
12-75 J.W.

BORAX 5 MOL

BORAX 5 MOL can economicaly replace regular Borax when used at the proper equivalent rates in solutions or fusions.

The economy of BORAX 5 MOL lies in the lower transportation, handling and storage costs of a more concentrated product. Only 76.4 pounds of BORAX 5 MOL are the equivalent of 100 pounds of regular Borax; hence the freight and other charges may be reduced by approximately 25%.

THEORETICAL COMPOSITION, *compared with that of regular borax:*

	Borax 5 Mol $Na_2B_4O_7 \cdot 5H_2O$	Regular Borax $Na_2B_4O_7 \cdot 10H_2O$
Sodium Oxide (Na_2O)	21.28%	16.25%
Boric Oxide (B_2O_3)	47.80	36.51
Water of Crystallization (H_2O)	30.92	47.24
Anhydrous Borax ($Na_2B_4O_7$)	69.08	52.76

PHYSICAL and CHEMICAL PROPERTIES

Formula Weight	291.35	381.43
Specific Gravity	1.815	1.73

MELTING POINT: Heated in a closed space, BORAX 5 MOL melts in its own water at temperatures below 200°C (392°F) but in the open, it loses water of crystallization below that temperature without liquefying. With continued heating in the open, and increasing temperatures, dehydration proceeds until Anhydrous Borax, $Na_2B_4O_7$, is formed with fusion point of 742°C ± 1° (1367°F).

SUBSTITUTION FACTOR: Based on theoretical compositions 0.764 pound of the BORAX 5 MOL plus 0.236 pound of water are the equivalent of 1 pound of regular Borax. Solutions made with BORAX 5 MOL on above basis are identical with regular Borax solutions. For solubilities in various solvents, pH values, and general industrial applications, see Technical Data Sheet No. MC-1A.

PACKAGING FACTORS: When substituting BORAX 5 MOL for regular Borax at the proper equivalent rates in dry mixtures, a decrease of approximately 15% in volume and 22% in weight is realized. This reduction in both volume and weight can result in savings through the use of smaller containers and from lowered handling and transportation costs. Another advantage in using BORAX 5 MOL in dry mixtures is that it is more compatible with materials which may pick up water from ordinary Borax or react with it to release moisture and cause caking.

SOLUBILITY IN WATER, as $Na_2B_4O_7 \cdot 5H_2O$

Temperature °C	°F	Percent Borax 5 Mol by weight of saturated solution	Pounds of Borax 5 Mol per U.S. Gallon of water	Parts Borax 5 Mol per 100 parts water by weight	Temperature °C	°F	Percent Borax 5 Mol by weight of saturated solution	Pounds of Borax 5 Mol per U.S. Gallon of water	Parts Borax 5 Mol per 100 parts water by weight
0	32	1.52	0.130 (2.1 oz.)	1.55	58.5	137.3*	21.02	2.38	29.00
5	41	1.89	0.161 (2.6 oz.)	1.93	60	140	23.16	2.73	33.23
10	50	2.35	0.202 (3.2 oz.)	2.43	60.8	141.4**	24.10	2.89	35.20
15	59	2.89	0.251 (4.0 oz.)	3.01	65	149	25.88	3.20	39.14
20	68	3.60	0.315 (5.0 oz.)	3.77	70	158	28.21	3.65	44.74
25	77	4.44	0.392 (6.3 oz.)	4.71	75	167	30.69	4.17	51.30
30	86	5.50	0.493 (7.9 oz.)	5.93	80	176	33.84	4.93	60.78
35	95	6.89	0·628 (10.1 oz.)	7.57	85	185	37.07	5.82	72.03
40	104	8.57	0.780	9.66	90	194	40.62	6.99	86.77
45	113	10.85	1.046	12.65	95	203	45.01	8.80	109.6
50	122	13.68	1.37	16.67	100	212	50.13	11.66	145.9
55	131	17.73	1.90	23.09	102.8	217***	53.17	13.96	175.0

Transition point to Kernite ($Na_2B_4O_7 \cdot 4H_2O$) **Transition point to 5 MOL Hydrate* ***Boiling Point*

BORAX 5 MOL

TECHNICAL GRADE

TYPICAL ANALYSIS

CHEMICAL	Granular, Types B, F and Powdered
Sodium Oxide (Na_2O)	21.7%
Boric Oxide (B_2O_3)	48.8
Water of Crystallization (H_2O by difference)	29.5
Equivalent Anhydrous Borax ($Na_2B_4O_7$)	70.5
Equivalent 5 Mol Borax ($Na_2B_4O_7 \cdot 5H_2O$)	102.1

IMPURITIES	Maximum (all forms)	Typical Gran./Powd. Type B	Type F
Chloride (Cl)	0.05%	0.032	0.042
Sulfate (SO_4)	0.08	< 0.05	< 0.05
Iron Oxide (Fe_2O_3) . .	0.004	0.003	0.003

SCREEN SPECIFICATIONS			AVG. BULK DENSITY	
Mesh Designation	U.S. Standard Sieve No.	Percent Cumulative	Pounds per Cubic Foot Loose Pack	Tight Pack
Granular	+8	0% Max.	63	71
Type B	+16	Trace	62	70
	+200	90% Min.		
Powdered	+70	8% Max.	38	54

AVG. PARTICLE SIZE DISTRIBUTION
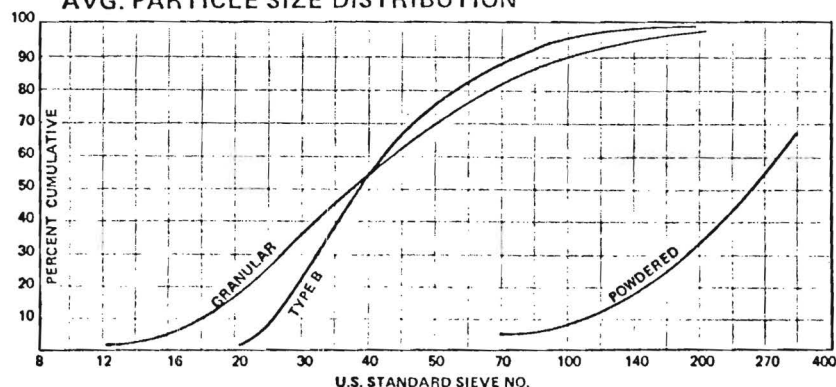
PERCENT CUMULATIVE vs. U.S. STANDARD SIEVE NO.

CONTAINERS
Multiwall paper bags with a polyethylene free film moisture-resistant barrier, 100 lbs. net. Also available in carload quantities in bulk.

INDUSTRIAL USES: Since BORAX 5 MOL, used at the proper equivalent rate, provides solutions or fusions identical in chemical composition with those of regular Borax, it may be substituted, at a saving, in all such applications where ordinary Borax is being used. Included in current applications of BORAX 5 MOL are such uses as: anti-freeze solutions, liquid starches, adhesives, and the manufacture of other borate compounds.

12-75 J.W.