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F O R E W O R D

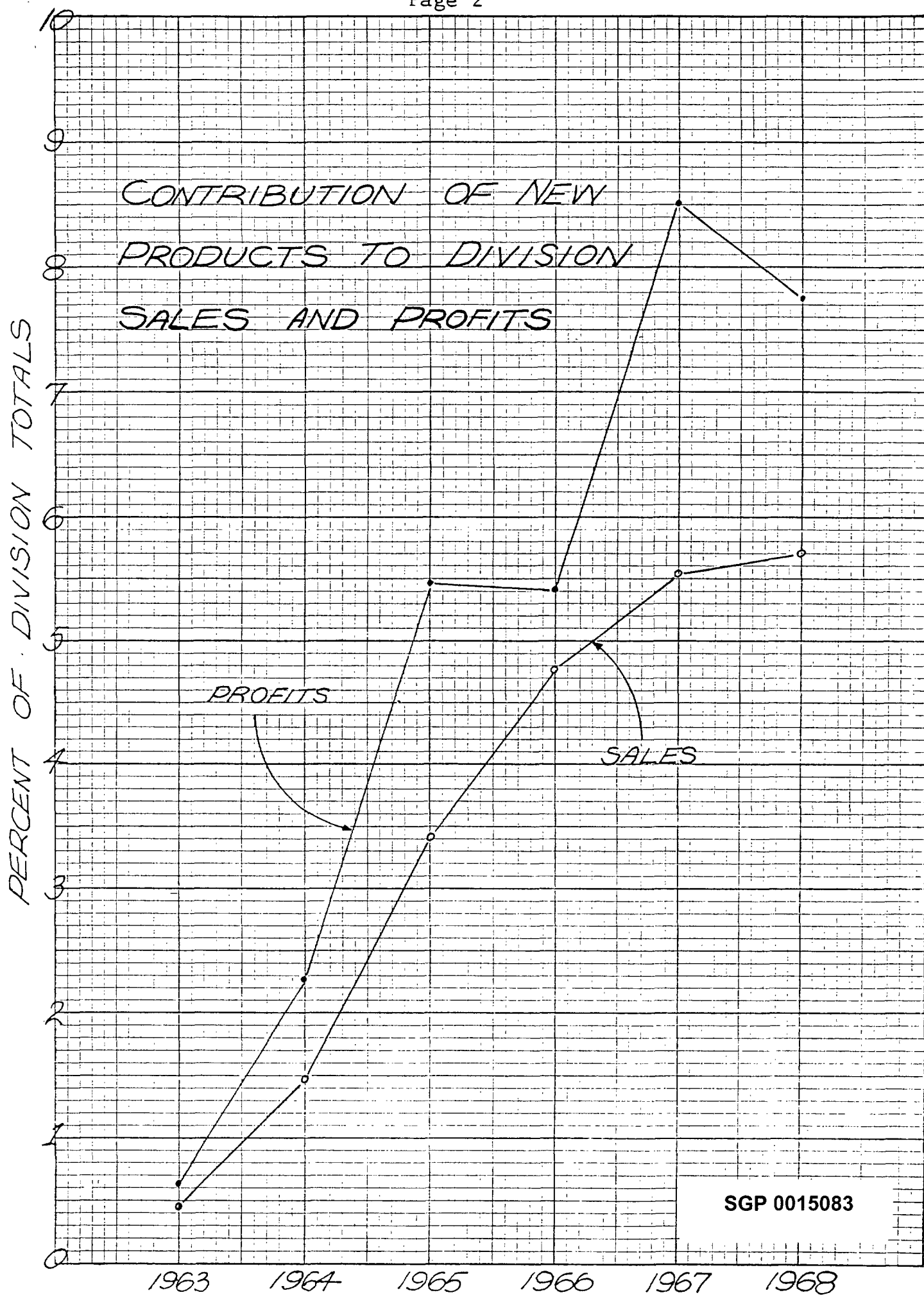
This is the semiannual report of the Gypsum Division Research Department for the period of July through December 1968. We have reported annual as well as semiannual results since this is the year end. As in the past, we have used profits generated by products developed through research as the chief measure of our performance. This does not include cost reductions or sales increases coming from research. Both of these are reported in the year in which they occur but not thereafter. The percent contribution of new products to the profits of the Division dropped slightly in 1968. This was due to sharply lower profits on Ready Mix and Triple Duty which were brought about by the market preparation for the Chicago and Marietta Joint System plants. We are confident that this is a temporary hesitation in the trend of an increasing new product contribution to Division results. This upward trend is shown by the graph on the next page. The 1968 return on our investment in gypsum research was -

$$\frac{\text{1968 Profits From New Products Developed Since 1961}}{\text{*Investment In Research Since 1961}} =$$

$$\frac{\$618,340}{\$1,150,000} = 53.8\%.$$

* Does not include capital investments.

A summary of 1968 activities, a detailed account of the last six month's research activities and the prospects for 1969 are included in this report.



SGP 0015083

1968 MARKET PERFORMANCE OF PRODUCTS DEVELOPED THROUGH RESEARCH

<u>Unit</u>	<u>Product</u>	<u>Sales Volume</u>	<u>List Sales</u>	<u>Gross Profit</u>
MSF	Dens-Cote Base (all)	22,184	886,890	226,264
MSF	Tile Backer Board	6,575	490,300	218,960
MSF	1/4" Sound Deadening Board	5,575	171,177	40,272
MSF	Radiant Heat Panels	7.8	2,910	1,020
Tons	One Day Joint Compound	270	34,255	2,441
Pails	Ready Mix	308,691	1,030,007	46,900
Tons	Triple Duty	5,874	809,777	42,505
Tons	Grabit	143.5	18,504	5,108
Tons	Bestex A	1,208	158,005	1,747
Tons	Bestex B	46	7,330	(1,819)
Tons	Bestex C	287	46,660	(5,493)
Tons	Bestex D	37	6,925	1,644
Tons	Dens-Cote Plaster	3,196	174,331	28,614
Rolls	Dens-Cote Tape	6,737	14,961	3,123
Tons	Ram Process Plaster	99.5	8,998	4,924
Tons	Denscal HP	170	9,767	2,144
			<u>\$3,870,797</u>	<u>\$618,354</u>

S U M M A R Y

RESEARCH BUDGET

\$238,000 was budgeted for gypsum research in 1968. We overspent by \$10,000 because of higher than expected pilot plant development costs in conjunction with molded grainboard. The chart on page 7 shows the distribution of the investment in gypsum research. A budget of \$247,000 has been approved for 1969.

NEW PRODUCT DEVELOPMENT

1. An all out effort on the radiant heat panel project has enabled us to progress to the point of having a limited number of panels available from Wilmington by January 1. In February we expect to be continuously producing panels on a profitable basis.
2. The new grainboard belt has just arrived in Brunswick and some other equipment revisions have been completed. We are at the final stage in determining whether molded grainboard can be manufactured and marketed economically.
3. The development of a gypsum fire door has been resumed. One of the problems has been to get test doors made for evaluation. The acquisition of Curtis Door should provide the means for getting over this hurdle. We need a lightweight gypsum block which will have the necessary physical properties and still be within our cost limits.
4. A completely new joint finishing technique has been discovered by Don Klus. It involves the use of a synthetic resin which has sufficient integral strength to eliminate the need for a reinforcing tape. As with most breakthroughs, much remains to be done to make the method practical for the contractor and profitable for Georgia-Pacific.

IMPROVEMENT OF EXISTING PRODUCTS

1. An unsuccessful fire test was turned into a favorable result when Ray Hinkel persuaded Underwriters' to grant us a type x 5/8" Firestop by interpolating from the test which failed. The board which U.L. has extended to us will save the company \$95,500 based on the sales of 5/8" Firestop in 1968. This formula will then be made available to our licensees for a \$2000 base fee and the standard royalty rate.
2. Based on our development and field test experience, an air separator will be installed at Acme to furnish a fine ground gypsum filler for ready mix. The substitution of fine ground gypsum for limestone will save 11¢ per five gallon pail or \$6,600 based on next years projected ready mix sales at Acme. If Acme is successful, a ready mix plant at Sigurd will be proposed. Sigurd is already making some textures with gypsum as the filler. The primary objective is the new business to be gained by having joint system available on the West Coast.
3. The hard end wallboard project has been discontinued because it did not create any spontaneous enthusiasm from the field and because the plant seemed to be unable to keep the process operating continuously.

SALES SERVICE

1. The one hour rating for the Dens-Cote/metal stud system was achieved. This is the rating Sales has been so anxious for us to get.
2. At the request of Marketing, a paper tape joint reinforcement method has been developed for the Dens-Cote system. This will be another alternative application for us to promote.
3. Pilot fire tests were made on partitions for Hill Rom Corporation and Angeles Metal Systems. These were requested by Marketing on the basis of developing future Firestop sales.

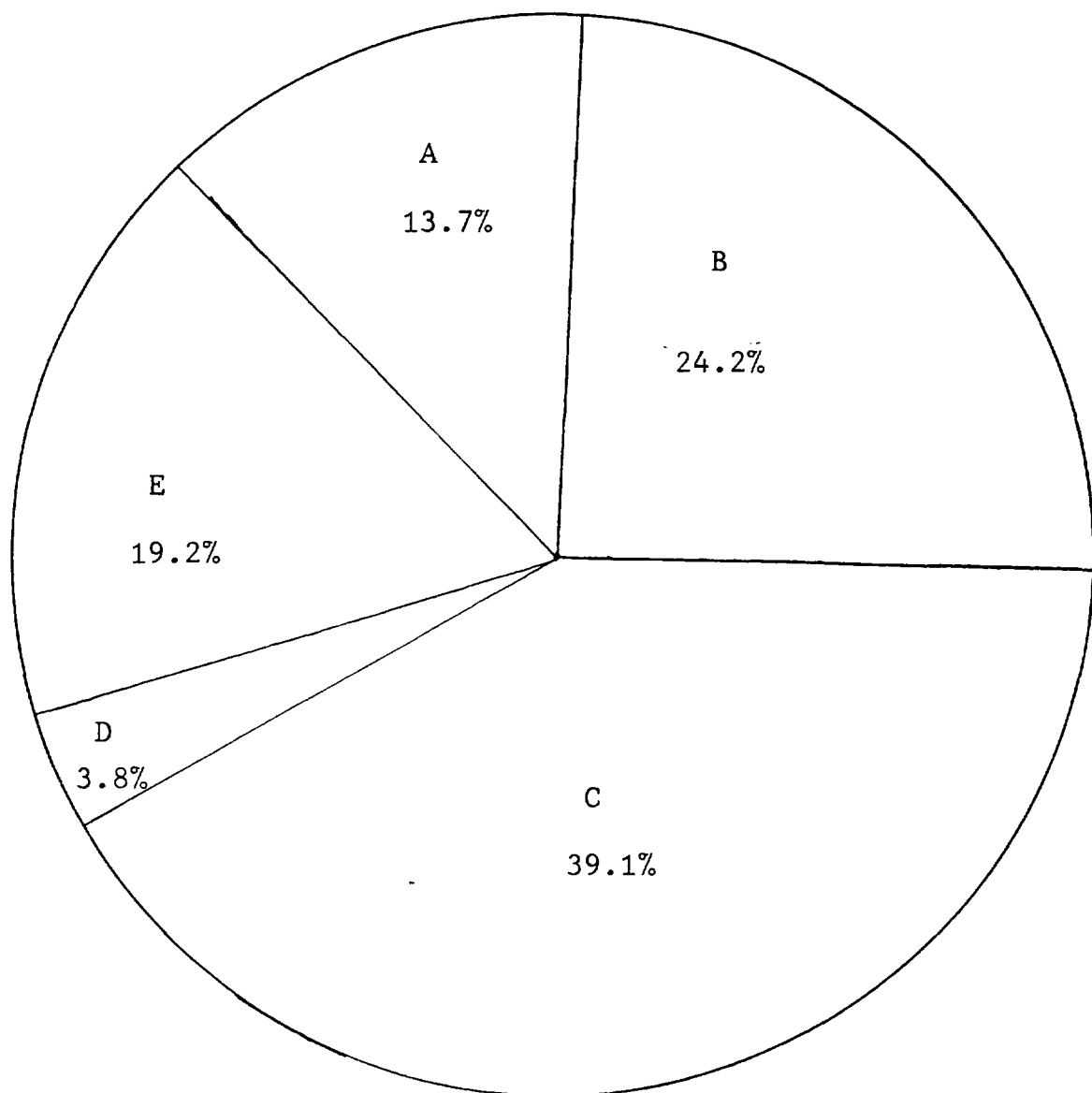
GYPSUM ASSOCIATION

The main projects on the Technical Committee agenda are to gain acceptance of gypsum board as a fire blocking membrane and to assemble a manual of fire and sound ratings. The success of the fire blocking membrane will depend upon the extent to which the industry can persuade code authorities to specify gypsum in roof and floor construction.

PATENTS

1. The infringement suit with National Gypsum Company was settled in our favor. National took a Firestop license at a higher than standard royalty, gave us paid up licenses for three of their patents and paid us \$4000 for the type xx and type xxx formulas. Our Firestop licenses netted us \$127,000 in royalties in 1968.
2. Canadian and U.S. patents on the processing of synthetic gypsum were issued to us recently. These patents could become useful if an economical source for synthetic gypsum develops.

DISTRIBUTION OF 1968 INVESTMENT IN GYPSUM RESEARCH



A -- Product Improvement

B -- Sales Service

C -- New Products

D -- Fundamental Research and Testing

E -- Other

NEW PRODUCT SECTION

1. Radiant Heat System

a. U.L. Testing

We received approval from Underwriters' for our radiant heat panel under their re-examination procedure. This means that the panel will be accepted by the various building codes throughout the country. We will be subject to periodic unannounced inspection by U.L. at locations where the panels are being manufactured in accordance with specifications established during the Underwriters' testing. We have subsequently received approval on a 240 volt half heat panel from U.L. This will give us a complete 240 volt system and do away with the 120 volt half heat panel we had. We will now be seeking acceptance of alternate methods of fabrication of the panels to facilitate their assembly.

We also expect to pass Underwriters' tests for a job laminated radiant heat system. We will market a 1/2" radiant heat board for this system and a 1/4" wallboard will be installed as the finish layer in the same manner as U.S.G.'s Thermalux system is installed.

b. Field Testing

About 10,000 square feet of radiant heat panel was installed in a rehabilitation job in Lancaster, Pa. The panels went in place easily and are reported to be functioning very well. We fabricated 3000 square feet of panel in Tigard to be installed locally as soon as Sales can arrange a trial. Panels will be sold and delivered to five jobs in the vicinity of the Wilmington plant in January. We will have passed through the field testing phase rather quickly as we expect to be selling radiant heat panels in some moderate volume by February 1969.

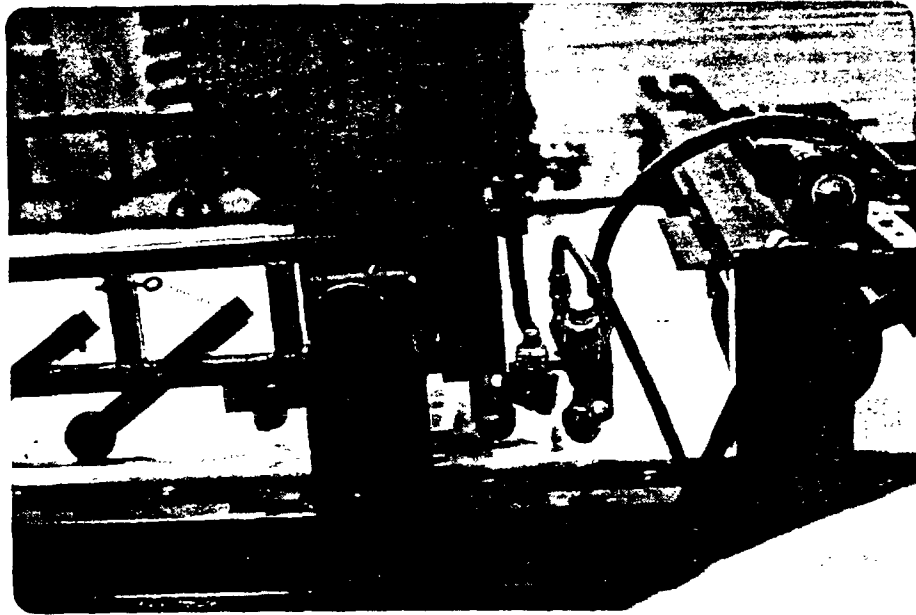
c. Manufacturing

In the interest of marketing our radiant heat panels at the earliest possible time, it was decided to design and assemble the processing equipment in Tigard. A complete unit to automatically dispense conductive adhesive and laminate the copper foil strips was designed and built by Don Klus and Bill Gettel. Components for grooving and drilling the back board to accommodate the pigtail were purchased by Engineering and assembled at Tigard. The grooving and drilling unit, the copper strip laminator and a glue applicator have been shipped to Wilmington. The glue applicator will be used in the lamination of the 1/4" and 3/8" boards. The copper strip laminator is already in operation and the other equipment will be in operation in January. This equipment was completely designed, assembled and will be in operation within three months. This will permit the Wilmington plant to start making panels on a profitable basis.

d. Laboratory Investigations

Two alternate methods to attach the electrical cable to the copper strips were found. One is a pop rivet connection and the other is a combination mechanical-solder connection. These will be submitted for U.L. approval. We have also considered slotting the board instead of drilling it and using pressure instead of grooving to accommodate cable and lead wires.

Another investigation is underway to find additives that will be used in the radiant heat board products to retard calcination. The combination of boric acid and potassium sulfate that we are currently using is about as effective as USG's patented glycerol-boric acid combination. We are looking to see if there are more effective calcination inhibitors that we can use. There are no long term results, but we have panels which have been in continuous operation for six months. Also, our test house in Paoli contained panels that were in constant operation for over a year. The previous panels did not contain calcination inhibitors; whereas, the panels we are now testing contain the boric acid/potassium sulfate mixture.



Manufacturing Radiant Heat Panels
Lamination of Copper Foil Electrodes



Installation of Panels in Strasburg, Pa. Ranch House

2. Molded Grainboard

a. Belt

The oak wood grain belt was made in three stages - a first impression, a hard rubber matrix and the final belt. The first impression was quite satisfactory, but the pattern was lost. We knew this was a possibility and that was the reason for having a matrix belt made. The hard rubber matrix belt was formed satisfactorily. The final belt, however, had a number of imperfections and we refused to accept it. This belt was remade from the matrix but still contained a few blisters and some other minor defects. These imperfections were repaired and the belt has been spliced and shipped to Brunswick. The belt is 120'1" long. We will attempt to index the boards so the break between boards occurs at a splice. The original plan was to tool the grain together at the splice, but we believe that it is highly unlikely that this would be successful. In order to do that, it would have meant adding another foot onto the length of the belt which would have prevented us from indexing boards as we are planning to do now.

b. Plant Operation

Several changes have been made on the plant equipment in preparation for the new belt. The entire stucco feeding system has been rebuilt to provide a more uniform feed. A new block grinder was built to replace the old one which was undependable. A spray system for the sealer was installed to apply the sealer before the grooving wheels. The grooving wheels break the sealer and when the stain is applied, it colors the grooves simultaneously. Another addition is a support for the wet board as it is being transferred from the forming line to the dryer carts. With these revisions and the new belt we are prepared to proceed with the plant trials. The future of molded grainboard will depend on the outcome of these trials.

3. Gypsum Fire Door Filler

The fire door filler investigation has just recently been resumed. One of the stumbling blocks in the project has

been to get some doors made so they can be tested. The acquisition of Curtis Door has provided us with a means for getting test doors made and will reciprocate by developing a low cost fire door for Curtis to sell along with their regular doors.

Some progress has also been made in formulating a fire door material. The use of Denscal as opposed to molding plaster requires less resin reinforcing in the foam and results in a lower raw material cost. It has also been found that a finer cell structure produced by higher speed agitation of the slurry will give greater strength at the same density. A number of fire door slabs will be cast using the new techniques and sent to Curtis. We will also ship some 1/4" sound deadening board which will be used to make a hollow core fire door. Doors will be made from both products and shipped to Tigard for testing.

Thus far, we have tested one competitive fire door (1 hour rated) in comparison with a layer of gypsum filler. Our filler performed significantly better in temperature transmission than the door with Kaylo (calcium silicate) filler. We have not yet run the hose stream portion of the test, but we can't conduct a fair test until we can make some doors with our filler material.

4. New Joint Treatment Method

It has been found that some epoxy and polyester synthetic resins are as strong as paper joint tape, even in thin applications. Sample joints have been made and found to be stronger than the board in many cases. This will be a major breakthrough if these resins can be adapted to the joint treatment application. A patent search did not reveal any prior art, so it appears that we may be able to get a patent. This project was delayed to permit work on manufacturing equipment for the radiant heat panel. We will resume this development as soon as possible. Evaluation of different resins, formulation to improve application properties and evaluation of methods of application will be the major areas of investigation.

IMPROVED PRODUCTS SECTION

1. Type X 5/8" Firestop

In the first half of 1968 a 5/8" board weighing 2275 lbs and containing 4 lbs of glass fiber/M and 20 lbs of raw vermiculite was tested on wood studs in an effort to get an hour rating. The test lasted only 57½ minutes. Subsequently, a series of tests were conducted here on the pilot furnace using various Firestop formulas at various weights and with varying quantities of raw vermiculite. We came to the conclusion that we would have a difficult time passing the test regardless what changes were made.

Ray Hinkel was able to convince U.L. that they should extend a 5/8" type x formula based on our unsuccessful test and the competitive tests that have been run. We proposed to let U.L. choose the weight and thickness limitations and Underwriters' agreed to conduct a study for no more than \$500. Another fire test would cost over \$2000, so we made application for the study after having assurance that U.L. would extend a board with reasonable specifications. The study was completed and we now have U.L. approval for a 5/8" type x board with the same formula we tested, but with 2375 lbs minimum weight and 0.615" minimum caliper. We could have gotten a 2350 lbs weight minimum, but the minimum caliper would have been 0.630". It was felt that it would be less restrictive to accept the extra 25 lbs than the increase in thickness.

The lower raw material cost will more than make up for the higher minimum weight, so we will change over to the 5/8" type x formula. We do not expect to get much demand for the 5/8" type xxx, so it will only be manufactured on special order. The transition to the type x formula will begin to take place in January 1969.

2. Gypsum Filler For Joint System

a. Ready Mix

Field trials were conducted on a ready mix with fine ground gypsum replacing limestone as the main filler. To have been able to make a direct substitution would have saved 17¢ per five gallon pail. Unfortunately,

the substitution of gypsum for limestone did not result in a satisfactory end product, so other formula changes were necessary. After the other changes which were deemed necessary, there is still an 11¢ per pail savings. It is our opinion that the gypsum formula is superior to the old limestone formula. The favorable field trials in Portland, Seattle, Dallas and Omaha seem to confirm that we have a satisfactory product. Some of the trials were made with an air separated gypsum and indicate that this material will be as good as the ground gypsum used in the initial trials. Acme will install the air separator which came from New Orleans. As soon as we have the fine gypsum available, we will begin making the transition at Acme. If their experience is good, we will recommend a ready mix plant at Sigurd using gypsum as the filler.

b. Textures

Two textures, Bestex A (no aggregate) and Bestex D (vermiculite aggregate), have been formulated using a gypsum filler. The gypsum used in the textures is regular landplaster since it is not necessary to have a special fine grind. Field tests have been only moderately successful, so reformulation is underway to make the refinements which will render the products acceptable. A number of competitors are furnishing a texture with expanded polystyrene. This aggregate has some advantages (it is white and is very lightweight), but special equipment is required to expand and grind the polystyrene. Our objective is to evaluate the texture market by making the vermiculite texture available before investing in equipment to use polystyrene. We have purchased enough raw materials at Sigurd to make 5 tons of texture which will be used for the market testing.

c. Other Joint System Products

Investigation is underway to develop Triple Duty, All Purpose and Laminating Compound formulas with gypsum. These formulas, along with the others, will be limited to Acme and Sigurd since it is cheaper to use limestone at the other manufacturing locations.

3. Hard End Wallboard

We applied resin to both ends of several million square feet of board at Acme. During this time nothing was said to see what reaction would come from the field. Much to our surprise, we did not receive any comment from the field other than a couple complaints when the boards stuck together. We received even more complaints from the plant because of their inability to keep the end sprays functioning. In view of the lack of enthusiasm from both Sales and Manufacturing, it has been decided to abandon the hard end project.

4. Joint System Formula Improvements

Thirty different emulsions were evaluated as alternate binders for ready mix. These were boiled down to four. One, Union Carbide W-130, was field tested and has been added to the approved list. Another, Monsanto TS-85, is ready for field testing. Two others appear to be satisfactory, but field trials will have to be arranged. Purchasing likes to have a number of alternate sources for such raw materials so they can bargain for the best possible price. However, our inability to get field trials has stymied complete evaluation of these alternate sources.

Another vinyl adhesive from Monsanto called RS-6319 has been found. This adhesive is a particularly effective binder and offers water resistance which is something the other vinyls lack. Some experimental work is being done to see if this adhesive can be used to improve our Triple Duty and One Day joint compounds. We can especially stand some better working properties for One Day and if the decoration problem can be solved, we might even be able to increase the sales of the product.

SALES SERVICE SECTION

1. One Hour Rating For Dens-Cote System On Metal Studs

We had passed the fire test but failed the hose stream, so we set up a pilot hose stream test to see what could be done to get the rating. Our pilot tests showed that the lath wetted through quickly. In order to reduce the wetting, we made a special run of paper removing the wetting agent and providing absorption by counteracting the size. In addition, the screws were spaced 8" o.c. instead of 12" o.c. Another partition was constructed at Ohio State and this time the test was successful. The results of the test indicated that the additional screws were what really made the difference. This ends several years of frustration in attempting to get this rating. The test report is being prepared and we should have it in January.

2. Hill-Rom Hospital Partition

Mr. Larry Lammers of Hill-Rom spent a couple days at Tigard to assist with the assembly and fire testing of the special partition he had designed. This partition was to fit in with various other hospital supply components which they sell. The pilot tests indicate that their partition has a good chance of passing a one hour fire rating.

3. Angeles Metal Displā Stud Partition

A pilot fire test of this partition showed that there is no chance of gaining a one hour rating without a major revision in the construction. Angeles wanted to know if they would be able to get a one hour rating at Underwriters' and we have advised them that they would be wasting their money to try.

4. Paper Reinforcing Tape For Dens-Cote System

When the Dens-Cote system was first developed, a paper tape was considered. The paper reinforcing tape was found to be more crack resistant than the glass fiber tape. However, when the paper tape wasn't covered, there was a difference in suction and when it was covered, the Dens-Cote didn't bond to the joint compound. In view of these problems, we recommended the glass fiber tape.

Just recently, the Marketing Department asked us to reconsider paper tape since some of our competitors were recommending it. Several 4' x 8' wall sections were built using paper tape and various types of joint compound to reinforce the joints. The joints were taped, then covered with the joint compound and finally, the Dens-Cote was applied. The 4' x 8' wall sections were subjected to the impact of the 60 lb sandbag in order to evaluate the bond of the Dens-Cote to the joint treatment. Ready Mix was the only joint compound which bonded satisfactorily with the Dens-Cote finish. Neither the regular casein material nor Triple Duty bonded well enough. We have requested a job trial and if it is favorable, the paper tape will be approved as an alternate method of joint reinforcement.

INDUSTRY SECTIONGypsum Association

A major project on the Association agenda is the use of gypsum wallboard as a fire blocking membrane under roof sheathing or subflooring. Some small scale fire tests have been run and show that gypsum wallboard will significantly improve the fire protection characteristics of the roof or floor construction. This test data will be presented to code authorities to convince them of the desirability of this use for gypsum board. A fire test of two shell houses, one without the gypsum protection and one with it, may be advisable to substantiate our claims.

We are heading a task force which has planned a group of tests which will be used to promote the use of gypsum wallboard under plywood paneling. This test program will be submitted for approval at the next Technical Committee meeting.

The fire resistance design manual was to be ready for printing by January 1969 but obviously will not be. Each time the Technical Committee meets a little more is accomplished toward assembling all the data, but there is nothing done in between times. It is unfortunate because once the manual is finished, it should be the most authoritative piece of literature available on fire and sound properties in building construction.

A.S.T.M.

The item of primary interest to us in Committee C-11 on gypsum is the development of new wallboard performance standards. It is the majority opinion that the present specifications are inadequate. The present specifications contain weight, dimension and flexural strength limitations. If some tests and test values for such properties as core hardness, nail pull through resistance and edge hardness could be agreed upon, it might provide a defense against some of the wallboard complaints that come up. The gypsum companies have dragged their feet so much on this that the industry is beginning to get some deserved criticism from the consumer interests. We have developed a nail pull through test which was assigned to us and are hopeful that the other companies will complete their assignments.

Specifications for plaster bonding agents and water resistant board were accepted and will be included in the ASTM standards.

PATENT SECTION

National Infringement

As previously mentioned, National Gypsum has decided to settle our infringement suit. We now license in one way or another just about everyone in the industry. Dierks, a former licensee of National Gypsum, will be talking to us and in all probability will take a license. Our Firestop patent has $4\frac{1}{2}$ years to run. We have a patent application on the type xxx formula which was submitted two years ago. If we can get this patent, we should be able to retain some of our royalty income, even after the current patent expires.

Patents Issued

Canadian and U.S. patents have been issued to us on our method of processing synthetic gypsum. These patents cover neutralizing by-product gypsum from the manufacture of phosphoric acid to make it suitable for manufacturing gypsum board. At the moment there are no sources of synthetic gypsum close enough to our market or plants to make this an economical proposition.

Patents Applied For

No new patents were applied for during the past six months. A patent search on the new method of joint finishing reveals no prior art. Other patent possibilities are the fire door filler process and the radiant heat panel. These will be reviewed to see whether there is a chance for patent and more important, whether there are sufficient benefits to warrant seeking a patent for any of these products.

PROSPECTS FOR 1969

Our objectives in 1969 are -

1. To continue product development, cost saving, sales service and other investigations which were begun in 1968. The value and the priority of these projects will be reviewed frequently to assure that the investment in gypsum research is directed to the best interests of the corporation.
2. To seek entirely new ways to gain technical advantages over our competitors. Each year some fresh new ideas are introduced and we are confident that 1969 will be no exception.
3. To increase our capabilities beyond what they are now. The purpose is to increase the efficiency and the scope of our function.

We begin 1969 armed with more experience and more research tools than ever before. We also enter 1969 with enthusiasm and the determination to make this our best year.