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May 15, 1981

MEMORANDUM

TO: The Regents of the University of Idaho

FROM: Richard D. Gibb
President

SUBJECT: Roof covering problems of the ASUI-Kibbie Activity Center

The university recently received a report from RUPO Technical Services, Inc., of Oak Creek, Wisconsin, that appears to confirm our suspicion that the current system of roof covering is not satisfactory. That firm performed a complete infrared scan of the entire roof area. The general observation was that in about 46% of the roof area some degree of moisture was found. Furthermore, significant variations in thickness of foam insulation and membrane covering were found, with the average being less than specified. Even in the area where the major 1978 repair was made, moisture was found.

Attached is a summary of the history of the roof covering problem on the dome. I caution you that it is only a summary, reflecting the highlights of a very extensive record of problems and responses over the past nearly 10 years of planning, construction, and repair of the dome roof. I urge caution in the use and response to this summary, as Jon Warren is performing a thorough review of the records to ascertain what legal action, if any, the university and board may have available. In the meantime, it is essential that the university get all the assistance possible from every source, including past participants, in finding a more permanent solution.

My perception of the situation is that problems of leakage may have resulted from design, materials, or workmanship. However, it also appears to be extremely difficult to tie down how much each of these factors have contributed to the problem. It must be acknowledged that the dome was one of the first of its kind of construction and that much better materials are on the market today than were apparently available in the mid 70's.

If time will allow and a temporary relief to the moisture problem can be found, it would seem that our best approach may be to identify several alternative roof covering systems, have samples of each of the most desirable systems put on the roof this summer when weather permits and evaluate them through the tougher winter months. Since the roof seems to have some unique characteristics, our confidence in looking at alternative

systems on other roof structures or laboratory testing is rather limited and I'm reluctant to recommend a permanent solution that will undoubtedly mean a significant outlay of funds before we have more thorough evaluations of design materials and application procedures than we may have had in 1975. If, however, an obvious permanent solution emerges immediately and time permits corrective action yet this summer, then that may be the best course to follow.

Hope a meeting on May 21 will produce some positive results. I am guardedly optimistic.

cw
Attachment

BRIEF SUMMARY OF ASUI-KIBBIE ACTIVITY CENTER ROOF PROBLEMS

Participants in Roof Covering Design, and Construction:

- Architect--Cline, Smull, Hamill, Associates (Glen Cline)
- Roof Structure--KKBNA, Inc., Consulting Engineers (Jerry York, Designer Donavon Nickel)
- Roof Structure--Trus Joist Corporation (Art Troutner) Materials
- Roof Structure--MacGregor-Triangle Co. Erector
- Roof Covering Consultant--Coultrap Consulting Services, Inc., (Keith Coultrap)
- General Contractor--Emerick Construction Co. (General, Mechanical, and Electrical), Portland, Oregon
- Roof Covering Applicator Subcontractor--D. K. Lane, Western Applicators, Lodi, California

Construction Phase:

The architect included in the bid specifications specific performance criteria and standards for the roof insulation and waterproof coating. A vapor barrier requirement was included in the bid specifications. The bidding and contractual documents placed the responsibility for the design, material specifications, construction, and maintenance warranty of the roof and covering end-wall construction upon the general contractor.

Two bid proposals were received. Emerick Construction Company of Portland proposed a roof and end-wall structural system utilizing a concept developed by Trus Joist Corporation. Emerick advised that the subcontractor for roof covering application would be CI2M, Inc., of Spokane. The weather resistant roof coating system proposed by Emerick included an asphalt film sprayed directly on the plywood, a $1\frac{1}{4}$" thick sprayed-on urethene foam insulation, and a covering of 19-mil thick Diathon acrylic elastomer membrane waterproof coating.

After an evaluation team accepted the proposal by Emerick and a construction contract was entered into, it was learned that CI2M, Inc., of Spokane was not licensed in Idaho. A request was then made by Emerick to substitute D. K. Lane, Western Applicators of Lodi, California, as the subcontractors for application of the coating. This request was approved, as well as a change in the proposed material for the waterproof membrane coating. The change in coating was requested because Western Applicators used a different supplier. Included in the general contractor proposal was a five-year guarantee for repair and replacement of defective materials or workmanship at no cost to the owner.

The certified date of completion of the roof and end wall construction contract was September 19, 1975.

Post Construction Water Problems:

Between the time of construction completion and the fall of 1977, several water leaking problems were identified. In a letter dated January 6, 1976, from Mike Thompson of Trus Joist Corporation to Glen Cline, concern was expressed about on-site observations of "moisture on billets, standing water in the arch support hardware, and some water on the playing field." In November 1976, the university physical plant director reported to Glen Cline roof leaking problems and requested corrective action by the contractor. In May 1977 Emerick Construction acknowledged the university's report of roof leaks and promised corrective action.

Generally, up until the fall of 1977, the corrective action on roof leaks was for the university to contact a firm in Pullman designated by the roof covering subcontractor to perform the corrective action. When the university could not get timely response to these requests, physical plant staff performed the corrective action which consisted of applying more waterproof membrane coating to the outside surface of the roof at places where leaks appeared to exist.

August 22, 1977--Glen Cline communicated to Sherman Carter his concern about the leakage problem, identified from personal inspection. A copy of the January 6, 1976, letter from Thompson of Trus Joist was attached to Mr. Cline's letter. The thrust of Glen Cline's letter was that apparent causes for some of the leaking problem were students walking on the roof and golf balls being hit onto the roof.

August 31, 1977--Sherman Carter responded to Mr. Cline's letter by indicating that while there may have been some early problems of the unauthorized persons being on the roof and a few golf balls being hit onto the roof, no evidence could be found on the campus that those activities were persisting and were causing the problem. While promises were made by Sherman Carter to Mr. Cline that every effort was being made to prohibit such unauthorized access to the roof, the need remained for corrective action on the roof leak.

September 7, 1977--During a visit to the campus by Mr. Sininger of Emerick Construction to settle a repainting problem on the end walls, demands were made by the university that roof leaks needed to be repaired immediately.

By October 27, 1977--The roofing covering subcontractor completed the application of about 20,000 square feet of waterproof membrane coating.

Beginning in October 1977, the university initiated daily inspections of the roof area and began finding leaks after heavy rains in November and December. D. K. Lane, Western Applicators, was requested in December 1977 to correct the 35 leaks reported.

January 25, 1978--In a letter from Glen Cline to Sherman Carter, concern was again expressed about the roof leak problem. He indicated that "time has come whereby effective permanent measures must be taken to ensure the continued structural integrity of the roof structural system." Mr. Cline proposed a thorough review and reevaluation of the problem, a determination of alternative solutions, costs, etc., and a plan to achieve a permanent solution in the next good weather period.

February 8, 1978--Meeting attended by Glen Cline, Zimri Mills of Trus Joist Corporation, and university personnel. Result of that meeting was that Mr. Cline was requested to develop a solution.

February 17, 1978--At the request of Mr. Zimri Mills of Trus Joist Corporation, the College of Forestry conducted a test of the roof's plywood covering and found rotted material. This information was transmitted to Glen Cline.

February 22, 1978--Mr. Keith Coultrap of Coultrap Consulting Services, Inc., made an inspection of the roof condition with Mr. Cline. Cutout samples showed penetration of moisture through the roof coating membrane, into the foam insulation and through to the plywood.

February 24, 1978--Glen Cline communicated to Emerick Construction with a copy to Trus Joist Corporation outlining the problem, indicating that immediate action must be taken to fulfill the terms of the construction contract and warranty agreements, and setting forth a definite time schedule.

February 28, 1978--Memorandum by Don Amos, university Business Manager, reporting results of telephone conversations with D. K. Lane, Western Applicators, in which that firm promised to removed all defective foam, replace all damaged plywood, and then would apply new foam and roof-coating membrane.

March 9, 1978--Letter received by Sherman Carter from James L. Berlin, Attorney representing Trus-Joist, in which objections to the "partial solution" to the problem proposed by D. K. Lane, Western Applicators, as outlined in Don Amos' February 28, 1978, memo the letter threatened withdrawal of warranty and court action to force permanent corrective action.

March 28, 1978--Letter to President Gibb from Peter Johnson, President of Trus Joist, in which Mr. Johnson transmitted a report from KKBNA about the need for a third party to be present during the proposed repair work to be certain that all damaged sheathing be removed. Professor Robert Hoyle of WSU's College of Engineering Research Division was recommended. That recommendation of Trus-Joist was accepted by the university.

April 18, 1978--Letter from Glen Cline to Sherman Carter in which he outlined the solutions required and action recommended.

Between April 18, 1978, and July 19, 1978--Dispute arose between general contractor and the university over proposed changes in waterproof membrane covering and area to be covered by new membrane. Coultrap Consulting Service recommended that the waterproof membrane material be changed to Diathon as manufactured by United Coating, Inc. The general contractor maintained that the warranty required replacement of original material only. Furthermore, the contractor would not cover the cost of applying new membrane coating to the entire roof. Pittsburg Testing Laboratories had evaluated for Coultrap Consulting Services the original membrane material and recommended that it not be used. The final solution was that the recommended membrane would be applied over the entire roof, but that the university would have to cover partial cost of $23,365 and that satisfactory completion of this would fulfill the general contractor's guarantee. Work was completed July 19, 1978.

August 21, 1978--University receives report from Coultrap Consulting Services on the repair work concluding that, "I feel the Kibbie Dome has been brought back to the standard of roofing quality that was called out in the original specifications and will provide many years of good service for the university."

Summer of 1979--Coultrap Consulting Services was appointed to make a complete review of the roofing system to determine how well the 1978 repair work had survived the winter weather. In a letter to Mr. Ed Stohs, Physical Plant Director, dated July 2, 1979, Mr. Coultrap offered the following conclusions from his inspection:

1. The overall underside of the roof deck appears to be in good condition and shows no evidence of serious on-top water leakage.

2. The exterior dome roof covering is in good condition and is much improved as a result of repairs undertaken during 1978. Some minor pinholes and penetrations are well within the scope of normal maintenance and do not constitute any serious problem to the performance of the roof covering.

3. The lower drain section flat roof areas on the north and south sides of the dome have been damaged by snow and ice loading. However, these areas are within general maintenance capability that can be performed by university personnel.

The consultant's report also contained summaries of his observations and recommended maintenance procedures.

August 1979--Mr. Glen Cline recommended that the roof structure design firm of KKBNA be retained by the university to inspect the roof structure to assure that after five years of experienced stress, exposure, etc., there were no structural or maintenance problems. He recommended that this be an on-going five-year program.

November 1979--Mr. Jerry York representing KKBNA submitted his inspection report, in which he indicated the discovery of dry rot within the plywood sheeting. He recommended that further study be done to determine the location of the dry rot.

March 1980--Mr. Robert J. Hoyle, Jr., of WSU was retained to locate dry rot areas. He used an electric resistance moisture meter, as well as taking core samples. Specific areas of rot were located. Results of these investigations by Mr. Hoyle were given to Mr. York of KKBNA to evaluate for potential structural problems. Assurance was given that adequate strength capacity still existed.

April 1980--KKBNA prepared detailed specifications for repair of the areas identified by Mr. Hoyle as having decay. Specifications were completed and received on June 30, 1980. In the meantime, Mr. Hoyle had conducted further core samplings to assure complete identification of decay areas.

August 1980--Materials were received for repair, but due to bad weather and ash cleanup problems, repair work was not completed until latter part of September 1980. Mr. Hoyle or his associate, Mr. John Talbott, an engineering consultant, observed, advised, and inspected all repair work.

Since Fall 1980--As a result the problems identified necessitated the 1980 repair; and because of continuing evidence of roof leaks, the university has concluded that the current roof covering system does not provide a permanent solution to the moisture and leak problem or provide adequate protection to the wood trusses. During the winter months, a search was initiated to identify other roof covering systems and to do laboratory evaluation on these alternatives. Mr. Hoyle and Mr. Talbott have assisted the university in this search and evaluation. To date, two alternative systems have been brought to the campus for study. Both include membrane materials not available at the time of the original design or specification for the roof covering.

A decision was also made this past winter to have a complete infrared thermography, analysis of the entire roof system performed when weather permitted. Such an evaluation has been completed and the final report of that evaluation was presented to the university on May 12, 1981. Among the many observations, the scan appears to show that moisture exists in about 46% of the roof covering and that the foam thickness varies from one-half inch to two inches and averages about five-eights of an inch. The scan would seem to confirm the university's previous assumption that a new and different roof covering system must be sought out.

On May 21, 1981, Mr. Walter Minnick and Mr. Art Troutner of Trus Joist, Glen Cline, Mr. Donavon Nickel, and Mr. Jerry York of KKBNA, Keith Coultrap of Coultrap Consulting Services, Inc., Mr. Robert J. Hoyle, Mr. John Talbott, and Mr. Peter Pavlich of RUPO Technical Services (firm from Wisconsin that performed the infrared scan recently) will meet with President Gibb and members of the university staff to discuss further courses of action to correct the ASUI-Kibbie Activity Center roof problem.

NOTES ON THE ASUI/KIBBIE ACTIVITIES CENTER ROOF

The situation which confronts us is not the simple inconvenience of a leaky roof. The concern is the decay of the untreated wood structure. Leaks lead to a wet and soggy layer of insulation. This creates an ideal environment for decay of the wood structure, which can proceed very rapidly whenever the insulation is wet. The insulation does not dry out when the leakage stops. It acts like a sponge. Water entering as a liquid is absorbed and stored and does not drain off. The water does not evaporate. The membrane, although somewhat porous, effectively separates the wet insulation from the flow of dry air over the roof, preventing evaporative drying. Below, the wood roof structure acts as a barrier to drying air inside the building. Sealed off on both sides, the insulation can not rid itself of water.

WATER SOAKED INSULATION CREATES AN IDEAL CONDITION FOR DECAY AND WILL NOT DRY OUT.

In this building the insulation rests on plywood and a structural deck, both of which play a very important role in the support of the building. As they decay the integrity of the building suffers. On some other domes this same type of insulation and roofing membrane are used. The insulation does not always absorb water as this does. I do not know why this insulation is different. It is supposed to be a closed-cell material and is not supposed to absorb water. Perhaps the method of application was faulty and the foam did not develop closed cells. Whatever the reason, there is a water absorbing insulation on some parts of the building and it must be removed and replaced with a type that will not hold water when leaks do occur.

THE DECAY IS IN THE VITAL STRUCTURE. THE WET INSULATION MUST BE REMOVED.

In other domes the consequences of decay are not so serious as they can be here. A concrete shell dome in contact with water would, of course, not decay. The wet insulation would cease to insulate. Freezing could cause some damage to a concrete shell, however. This would proceed more slowly, being limited to periods of very cold weather, whereas in a wood structure decay can proceed most of the time that the wood is wet.

Wood domes like the Ensphere at Flagstaff, Arizona, or the Montana State University Dome at Bozeman, or the new Sports Arena at the University of Wyoming in Laramie, all have a structural system of glulam beams sheathed over with a wood skin. If this skin becomes wet and stays that way it can decay without causing immediate structural weakening. The skin can be removed and replaced without affecting the integrity of the supporting structure. With such domes there is adequate time to shop around for solutions without risking extensive permanent damage. This is not so for the Activities Center. Every instance of decay is eating into the reserve strength of this building. Action has to be prompt or we will have an increasingly severe situation. One year is enough time for severe damage to take place.

OTHER DOMES USE SIMILAR ROOFING BUT THE IMMEDIATE CONSEQUENCES OF DECAY ARE LESS CRITICAL.

The Laramie dome is to have much the same insulation and membrane, polyurethane foam and Hypalon, as the Kibbie. The University of Wyoming engineers anticipate recoating the Hypalon membrane every five years as a regular maintenance expense. Should it leak the insulation can be removed and

if necessary, decayed wood can be replaced. The beams are below the roof decking and do not lie in immediate contact with insulation and will not become wet so promptly when a leak occurs. That building is less vulnerable to structural damage. If leaks occur there will be more time to correct the problem.

LEAKS CAN OCCUR AND A FIVE YEAR RECOATING OF THE MEMBRANE IS AN ACCEPTED POSSIBILITY FOR HYPALON.

Because of this vulnerability we have to stop the decay, repair the structural damage that has occurred, and put a non-absorbent, closed-cell insulation and a good membrane on the roof. At the same time we must provide protection from possible condensation. I will explain how we propose to do that.

WE MUST STOP THE DECAY, REPAIR THE DAMAGE AND GET A NON-ABSORBING INSULATION, AND A MEMBRANE AND VAPOR BARRIER ON THE STRUCTURE.

First we will remove all the insulation. None of it is reliable any more. We will inspect the structure as the insulation comes off and direct reconstruction of the damaged wood in the light of that inspection. How we do the reconstruction will depend on the conditions we find.

The infrared scan indicates that severe decay of the plywood is probably extensive with damage to the deck somewhat less widespread. The repairs done last summer appear to be doing a good job of keeping that portion of the roof dry.

DECAY OF MAIN DECK PROBABLY NOT TOO BAD YET, BUT LIKELY TO SPREAD. WE CAN NOT WAIT ANOTHER YEAR.

Whenever we find decay we will remove it and apply a generous soaking of wood preservative to the structural deck. It would have been better, in retrospect, to have pressure treated the deck before it was installed. That is not possible now. Surface treatment is the best we can do. It should kill off any active fungi which may remain after we cut away the obviously decayed wood and poison the surface to further feeding of fungi.

We will replace all decayed plywood with treated plywood. We may replace all plywood with treated plywood. Treatment will be either 5% Pentachlorophenol in volatile solvent, or Wolmanizing. Either one is effective but I prefer the Pentachlorophenol as it is less corrosive to fasteners. Wolmanizing may be more compatable with the insulation.

ASSESS DAMAGE - SPECIFY REPAIR ON THE JOB - SURFACE TREAT THE DECK - PRESSURE TREAT ALL NEW PLYWOOD -

While we don't believe that condensation has been the prime source of the moisture in the structure, the thin insulation discovered by the infrared scan, indicates that condensation could occur and should be recognized as a possibility. Aproperly designed vapor barrier must be a part of the new roofing. This vapor barrier should be under the plywood, for maximum effectiveness.

VAPOR BARRIER AN ESSENTIAL FEATURE.

Over this we would put down a layer of polystyrene foam insulation board, 1.5 to 2 inches thick. Dow Type RM "Beadboard" is the preferred type as it is closed cell, won't absorb water, and acts as a vapor barrier. It has proven itself by extensive use in a variety of applications on old and wet jobs.

CLOSED - CELL POLYSTYRENE FOAM BOARD.

Why use board instead of sprayed-on foam? There are several reasons:

It is non-absorbent - impervious to water.

It is uniform in thickness and will give a smooth surface less prone to sliding snow damage and assure adequate insulation at all points.

It is factory made under close quality control, can be inspected prior to installation - dependable quality.

It is a vapor barrier itself if joints are sealed.

It can be mechanically fastened to the deck.

I do not rule out the possibility of a good sprayed on foam of the right properties, but past experience here strongly biases us against it.

The final outside surface membrane will be selected to minimize the prospects of leaks. We can not guarantee that leaks will not occur on a structure with such a large area. But we can select a membrane that has the highest prospects of leak resistance. We haven't chosen one yet but we have two in mind. One is Chevron Industrial Membrane (50 mils, almost 1/16 inch thick) and the other is US Minerals Weathershield Flexhide LR 50 (45 mils) both much thicker than the Hypalon/Diathon (12 mils) now on the building.

THICK, TOUGH SURFACE MEMBRANE FOR MAXIMUM LEAK AND ABRASION RESISTANCE.

We are also looking at the possibilities of a 3-ply hot-mopped asphalt and felt built-up roof. This is a type that has a long history of good performance. The problem we are checking out is the feasibility of putting it on a 50 degree roof slope which is steeper than usual for such membranes. It is a matter of application feasibility rather than performance on the slope.

With the best possible membrane we shall have absolutely minimized the chances for leaks. With the polystyrene foam insulation we will have eliminated the possibility of a water sponge on the roof. If a leak does occur the water will not accumulate. The "beadboard" won't soak it up. The treated plywood won't decay even if it should get wet. The surface treated deck will have as much decay resistance as we can provide.

We believe the prospects of leaks are very small with a system of the type described here and we feel the structural consequences of leaks are much less severe than the situation we now face.

BEST LEAK PROTECTION WE CAN DEVISE
NON-ABSORBENT INSULATION
PRESERVED PLYWOOD
SURFACE TREATED DECK
ADEQUATE INSULATION
PROPER VAPOR BARRIER

Robert J. Hoyle, Jr., P.E.
5/18/1981