MONTGOMERY COUNTY COUNCIL

OFFICE OF LEGISLATIVE OVERSIGHT
MONTGOMERY COUNTY, MARYLAND

REPORT #78-3

APRIL 10, 1978

TITLE

An Evaluation of Policies and Procedures Concerning the Premature Failure of Some Schools Roofs and Those of Selected Buildings of Other County and Bi-County Agencies, other Counties and the Private Sector.

CONTENTS

I. SUMMARY AND MAJOR CONCLUSIONS

The Montgomery County Public Schools have experienced premature failure of some of its built-up roofing systems installed in the late 1960's and early 1970's. A survey by the Office of Legislative Oversight revealed similar premature roofing system failures on a facility belonging to County government, and on buildings of the Montgomery College, Washington Suburban Sanitary Commission, other Metropolitan area jurisdictions and locally based private corporations.

The Montgomery County Public Schools staff, and the construction and maintenance staffs of the other public agencies in the County are knowledgeable of the various causes for roofing system problems and are directing a cooperative effort toward minimizing future premature failures of built-up roofing systems.

The specific causes for these roofing system failures are many and technical; however, most are included under one of four broad categories: 1) poor design and inadequate specifications; 2) defective materials; 3) improper workmanship; and 4) owner mistreatment.

The major conclusions of this evaluation are:

Premature failures of built-up roofing systems have occurred on public buildings belonging to the Montgomery County Public Schools, Montgomery College, Washington Suburban Sanitary Commission and on one facility of County government.

Public employees with duties associated with the roofing systems of County facilities which experienced premature failure appeared to have performed those duties in a reasonable and proper manner.

Current public employees in supervisory and maintenance positions associated with the roofing systems of County facilities demonstrate a high degree of sensitivity to, and knowledge of, roofing system design and specification problems.

The County agencies examined in this report--Montgomery County Public Schools, County government, Montgomery College, Washington Suburban Sanitary Commission and Maryland-National Capital Park and Planning Commission have active roofing system inspection and preventive maintenance programs for existing roofs and programs to supervise closely the installation of new and replacement roofs.

II. AUTHORITY AND SCOPE

1. Authority: Council Resolution No. 8-1418, subject FY 78 Work Program of the Office of Legislative Oversight, adopted June 28, 1977, directed that this Office evaluate Montgomery County Public Schools' (MCPS) actions in determining the reason(s) for the premature failure of some school roofs.

2. Scope: To review the data and results of the independent roofing consultant retained by the MCPS and to evaluate the MCPS actions concerning the school roof failures.

III. BACKGROUND, FACTS AND DISCUSSION

Background

1. The Council noted that there have been a number of failures in school roofs constructed in the late 1960's and early 1970's. The MCPS staff was equally concerned and had initiated actions to secure an independent roofing consultant's opinion on one of the roofs which had prematurely failed. Informal inquiries by the Office of Legislative Oversight to other County agencies and other Metropolitan Washington Area governments revealed a similar pattern of premature roof failures.

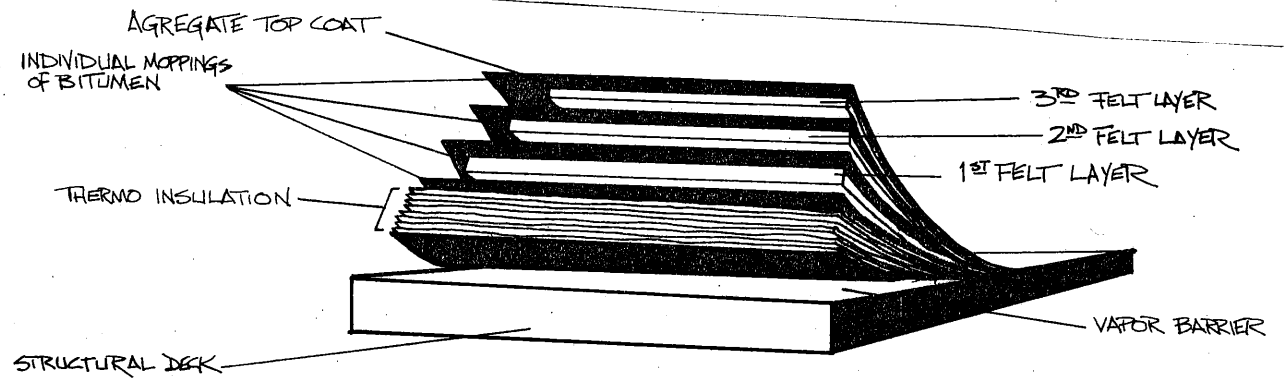
2. The Office of Legislative Oversight (OLO) conducted this evaluation during the 2nd Quarter FY 78 using information developed from the MCPSs' roofing consultant's report; another independent consultant's report on the Public Service Training Academy roof; through interviews with County personnel and officials of other Metropolitan area jurisdictions who are responsible for roof construction and maintenance; from information provided by private corporations; and from technical data on roofing systems provided by the National Bureau of Standards.

3. This report is not intended to be a technical discussion of roofing design, material or construction. Rather, it is a "layman's" review of basic roofing terms, characteristics and problems as they relate to County buildings. However, an understanding of some basic terms is necessary for a discussion of roofing problems.

4. Glossary.

1. Roofing system. In a level or low-slope roof, the roofing system is an assembly of interacting components designed to protect the building interior, its contents and occupants from the weather. The four basic components of the built-up roofing system are: a) structural deck (of

wood, metal, concrete or other material); b) vapor barrier (plastic or other impermeable membrane to retard passage of water vapor through the roof); c) thermal insulation (to retard flow of heat); and d) the built-up roof membrane. Below is a schematic of a three-ply roofing system.



-PICTORIAL EXPANSION-

THREE-PLY ROOFING SYSTEM

2. Roof membrane. The actual waterproofing component of a roofing system. The membrane is a laminate comprised of two basic materials: a) an organic (felted paper or shredded wood fibers) or inorganic (asbestos or glass fiber) felt which stablizes and strengthens the waterproofing agent; and b) the bitumen waterproofing agent--either a petroleum base asphalt or a coal tar pitch.

3. Built-up roof. In a flat or low-slope roof, the term used to describe fabricating in place of layers or "plys" of roof membrane and a top surface of mineral aggregate to protect the last bitumen layer from the damaging effects of infrared and ultra-violet solar rays.

4. Ply. A layer of felt in a built-up roofing membrane. A four-ply membrane has at least four plies of felt at any vertical cross section cut through the membrane.

5. Two-ply roof. A roof which has at least two plies of coated felt at any vertical cross section cut through the membrane. Utilizes felt which is coated with asphalt at the factory and coated with more asphalt at time of installation.

6. Flashing. A connecting device or membrane used to provide water tight protection between the roofing material and other parts of the structure (vents, parapets, expansion joints, skylights, drains, built-in gutters, etc.) or other places where the roof membrane is interrupted.

General

5. Most of us are familiar with the common, steep-slope roof of slate, wood shingle or composition material found on residential and smaller buildings. Steep-slope roofs require minimal maintenance and are usually serviceable for two or more decades with premature failure usually the result of fire or severe weather. Such high reliability is not found in level and low-slope built-up roofs found on larger buildings. One technical publication on built-up roofing systems estimates that 10 to 15 percent of low-slope built-up roofs fail prematurely--in "from one to five years."[a] Although there may be differences in the estimate of occurrences of premature failure of roofing systems, there is general agreement that these failures are extremely costly. Likewise there is a consensus that a requirement exists for special attention when designing and constructing a level or low-slope roof.

6. Premature failure of roofs has occurred on buildings of the Montgomery County Public Schools system, Montgomery College, the Washington Suburban Sanitary Commission, private agencies based in the Metropolitan area and in other local jurisdictions. Within County government, the Public Service Training Academy roof failed prematurely. The specific causes for these failures are many and technical; however, most are included under one of four broad categories: a) poor design and inadequate specifications; b) defective materials; c) improper workmanship; and d) owner mistreatment.

MCPS Roofs

7. Premature roof failures of Montgomery County Public Schools have been a costly but not a frequent problem. In the past two decades approximately 150 facilities have been constructed by MCPS of which approximately six have had premature roof failure. The 150

(a) Griffin, C.W. Manual of Built-up Roof Systems, New York: McGraw-Hill, 1970.

facilities represent entire buildings and additions/expansions. The roofs which have failed were all of two-ply construction and were built in the early 1970's. The facilities were: Robert Frost Junior High, the Gaithersburg High School auditorium and Saddlebrook, Stonegate, Tuckerman and Wayside Elementary Schools. The Saddlebrook roof was replaced in FY 76, and Stonegate, Tuckerman and Wayside roofs were replaced in FY 77.

8. The MCPS engaged a consultant to investigate the roof problem at the Robert Frost Junior High School. The investigation included a review of the architectural drawings, on site examination of the roof and laboratory analysis of samples of the vapor barrier bitumen and insulation which were cut from the roof. The consultant's report will not be discussed here in detail as the roof of the Robert Frost Junior High School and the other five schools are under litigation; however, the conclusion of the consultant was that water did enter the roofing system because of openings in the roofing membrane resulting from design defects of the two-ply roofing system and material deficiencies.

9. The deteriorated roof of the Robert Frost Junior High School was replaced in the summer of 1977. The Gaithersburg High School auditorium roof has not as yet been replaced.

Other Examples of Premature Roof Failure

10. Public Service Training Academy. The Public Service Training Academy experienced premature failure in the two-ply roof. An independent consulting engineer was engaged to perform a field investigation and laboratory analysis of the roof design, materials and construction. As in the case of the Montgomery County Public Schools, the PSTA roof failure is under litigation with the consultant's report a part of that litigation. However, the report's conclusions point to failures to meet project specifications and faulty workmanship during construction. As of this writing, the PSTA roof has not been repaired or replaced (See paragraph 18c).

11. Other County Agencies. The Washington Suburban Sanitary Commission has encountered roof problems. Among the causes of these problems were improper application of waterproofing; poor waterproofing around the many penetrations in the roof; damage by maintenance men working on the roof; and incorrectly designed flashings which allowed water to flow over the flashing lip. Montgomery College has likewise experienced problems with built-up roofs on facilities constructed since 1965. The causes for these failures are not unlike those of the Montgomery County Public Schools roofs, to include failure of the two-ply roofing systems. The Maryland-National Capital Park and Planning Commission reported that they had no new roofs, but were aware of the potential for roofing system problems.

12. Fairfax and Arlington Counties. Fairfax and Arlington County Public Schools have experienced problems with both two-and three-ply roofs. The causes of these problems are similar to those found in Montgomery County: design and specification errors, improper workmanship, breaks and tears in the roof caused by workmen servicing roof mounted air conditioning units, and meterial defects. Both counties have initiated corrective and preventive measures which are discussed later in this report.

13. Private corporations. Informal converstaions with construction supervisory personnel of the Marriott Corporation and Hechinger's indicated that roofing system failures were not limited exclusively to the public sector. The roofing problems of both these corporations are remarkably similar to ours, and include design errors (using the two-ply roof); construction deficiencies (laying the membrane during inclement or marginal weather); and damage to the roof after construction by maintenance workers (puncturing the roof membrane with a ladder or sharp tool).

Analysis of Premature Failure of Roofing Systems

14. Analysis of premature failures of built-up roofing systems in both the public and private sector reveals a similarity of problems and probable causes. The various causes for roofing system failures are presented below.

15. Problems associated with built-up roofing system failures. The major problem is, of course, that the roofing system failed to prevent water from entering the interior of the building. The usual result is that the building's contents and structure (floors, fixtures, ceiling, wall covering) are damaged. In addition, moisture absorbed into the roofing system insulation causes it to deteriorate and lose its insulating property.

16. Causes of roofing system failures. Outlined below are some of the causes for built-up roofing system failures as presented by the various public and private agencies mentioned earlier in the report. Also included is information on causes for premature failure from the the Center for Building Technology, Institute for Applied Technology, National Bureau of Standards and from a research report on roof systems for the General Services Administration.

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a. Basic design weakness of the roofing systems, particularly the two-ply roofing system. There was nationwide acceptance and use of the two-ply system, especially in the late 1960's and early 1970's as an efficient, economical roof membrane. Although many two-ply roofs have not

failed, there appears to be a higher incidence of premature failure in the two-ply system than the three, four-ply or higher multi-ply systems. This evaluator cannot fault any agency for selecting the two-ply built-up roofing system. Architects, roofing material manufacturers and roofing contractors endorsed it as a technologically sound system. As indicated earlier, the two-ply system was installed on many public and private facilities. At the time of this evaluation, agency personnel indicated to this evaluator that they are not using the two-ply system in current or planned construction or in roof replacement projects. The two-ply roofing system was not used on any of the school roofs replaced in the last few years.

b. Design of the roof was level or of such low-pitch that water could not drain off the roof, causing "ponding" and contributing to the deterioration of the roof. All County agencies indicate that present roof specifications call for a minimum slope of 1/4" per foot.

c. Installation of the roof in inclement or marginal weather permitted excessive moisture to enter the roofing system.

d. Excessive moisture in the felt rolls introduced during the manufacturing process or caused by exposure to rain, snow or high humidity during storage.

e. Improper preparation of the structural deck: large cracks and openings; a rough surface which cuts the vapor barrier membrane; or instability which permits lateral movement or vibration.

f. Excessive penetrations through the built-up roof for vents, air conditioning units, blowers and other mechanical units.

g. Careless and unprofessional installation. Examples include failure to install the specified vapor barrier; breaks in the vapor barrier and insulation; bare patches where no bitumen was applied; bitumen not applied at the proper temperature or viscosity; missing or improperly installed flashing; insufficient expansion joints; and punctures in the vapor barrier or felt membrane caused by workmen's boots or tools.

h. Excessive rooftop traffic by workmen and unauthorized trespassers.

i. Failure to discover and correct minor roofing problems (tears, blisters, wind damage, blocked drains and gutters, etc.) before they became major problems because of a poor inspection and maintenance program.

Preventive/Corrective Actions to Minimize Premature Roofing System Failures

17. Agencies are engaged in a variety of actions to minimize future premature failure of built-up roofing systems. Presented below are a summary of those actions.

a. Design and specifications.

(1) The two-ply system will no longer be used until such time that tests and technical improvements guarantee it to be a reliable roofing system.

(2) All built-up roofs are designed with a minimum slope of 1/4" per foot.

(3) Rigid specifications for structural deck and roofing material, especially the minimum strength and moisture content of the felt, bitumen (asphalt or coal tar pitch), vapor barrier and insulation.

(4) Reduction to an absolute minimum the number of roof penetrations and items of equipment installed on the roof.

b. Installation and supervision.

(1) Closer supervision by agency personnel or a professional consultant during all phases of the construction of the roofing system. The Montgomery County Public Schools currently require that a building construction supervisor and roof maintenance personnel be present and oversee the installation of the entire roof. For future construction the Department of Facilities and Services has indicated that a roofing consultant will be engaged to review the design and specifications of built-up roofing systems before approval of the project is given, and to monitor installation of the roof. Montgomery College conducts an active, full-time inspection and supervision program during construction of built-up roofing systems, which includes taking samples for visual inspection. Washington Suburban Sanitary Commission and the Maryland-National Capital Park and Planning Commission have policies which require close supervision of roof maintenance and installation programs. The private corporations examined by this evaluator generally employ the same method as MCPS, i.e. construction supervisory and roof maintenance personnel present to assure satisfactory installation of the roofing system. Each of the methods used clearly demonstrates an awareness of the importance of closely supervising the design and installation of a built-up roofing system.

(2) Installation of the built-up roof will not be permitted in inclement or marginal weather.

c. Inspection and Preventive Maintenance.

The Office of Legislative Oversight is currently conducting a separate evaluation on inspection and maintenance for all County agency facilities. However, a comment on roof inspection and maintenance--or more specifically, preventive maintenance--is appropriate here. Roofing systems deteriorate with age and exposure to wind and weather/temperature changes. Periodic inspection of roofing systems and timely correction of tears, breaks, blisters, bare spots and similar problems prevent costly major repairs. All County agencies have active inspection and preventive maintenance programs which include an inspection check list. At Exhibit A is an example of a built-up roof inspection form developed by the Institute for Applied Technology, National Bureau of Standards and reproduced here with their permission.

OTHER MATTERS

18. County Council Resolution No. 8-1418, subject, FY 78 Work Program of the Office of Legislative Oversight, includes a general work project to evaluate County agency policies, procedures and attitudes. Outlined below are pertinent observations on agency/department policies, procedures and attitudes and on other matters related to roofing systems.

a) Cooperation, coordination and communication: In accomplishing this evaluation, OLO received complete cooperation from the Department of School Facilities, Montgomery County Public Schools; the Department of Facilities and Services; and construction/maintenance staff personnel of Montgomery College, the Washington Suburban Sanitary Commission and Maryland-National Capital Park and Planning Commission. Their knowledge of, and attention to, roofing systems were most apparent. There was clear evidence that agency staffs are exchanging information concerning roofing system problems.

b) National Bureau of Standards: This evaluator discussed County roofing problems with William C. Cullen and Robert G. Mathey of the Center for Building Technology, Institute for Applied Technology, National Bureau of Standards. Their cooperation and information was most helpful in developing background data on premature failure of level and low-slope roofing systems. In the past, County personnel have visited the NBS Institute for Applied Technology and discussed our roofing problems. In the opinion of this evaluator, liaison with the Institute should be continued, with special emphasis on staying abreast with the technical tests and performance evaluations being conducted by the Institute on roofing materials and application techniques. At Exhibit B is a list of some of these technical publications relating to roofing systems.

c) Timely repair of faulty roofs. Most faulty roofs are repaired in a timely manner to reduce further damage to the roofing system and the building's interior. However, when the cause of the roof failure is subject to litigation there is a possibility that repairs/replacement could be delayed. Such delay should be avoided because of the high probability for additional damage with the concomitant additional costs. A case in point is the PSTA roof. It is this evaluator's opinion that roof repair/replacement should be initiated as soon as possible to prevent further damage to the interior of that building.

IV. CONCLUSIONS.

1. Conclusion #1:

a) General: Premature failures of built-up roofing systems have occurred on public buildings belonging to the Montgomery County Public Schools, Montgomery College, and the Washington Suburban Sanitary Commission and to a facility of County government.

b) Specific:

1. Although not the sole cause, premature failure of built-up roofing systems on County buildings in the County has been primarily caused by failure of the design, specifications, materials and workmanship associated with the two-ply roof.

2. MCPS buildings which have had roofs to fail prematurely represent a small percentage of MCPS facilities.

3. Fixing responsibility for the cause(s) of the premature failure of MCPS roofs and the roof of the Public Service Training Academy is currently a matter of litigation.

2. Conclusion #2:

Public employees with duties associated with the roofing systems of County facilities which experienced premature failure appeared to have performed those duties in a reasonable and proper manner.

3. Conclusion #3:

Public employees in supervisory and maintenance positions associated with the roofing systems of County facilities demonstrate a high degree of sensitivity to, and knowledge of, design and specification problems.

4. Conclusion #4:

The County agencies examined in this report--Montgomery County Public Schools, County government, Montgomery College, Washington Suburban Sanitary Commission and Maryland-National Capital Park and Planning Commission currently have active roofing system inspection and preventive maintenance programs for existing roofs and programs to supervise closely the installation of new and replacement roofs.

5. Conclusion #5:

Roof failures were not limited to public agencies; the private sector has experienced similar problems.

V. RECOMMENDATIONS.

1. County agencies should continue active roofing system inspection and preventive maintenance programs, and close, full-time supervision of installation of new and replacement roofs.

2. Public employees in supervisory and maintenance positions associated with the roofing systems of County facilities should continue an active program of sharing roofing system technical and preventive maintenance knowledge.

VI. AGENCY COMMENTS AND OFFICE RESPONSE.

1. General: A draft copy of this report was sent to the County Executive and four County agencies. Written approval was received from the Superintendent of Schools (see below) with oral comments from the other responding agencies. This final report reflects all changes recommened by agencies submitting comments.

2. Comments of the Superintendent of Schools.

March 8, 1978

MEMORANDUM

To: Mr. Andrew Mansinne, Jr., Director, Office of Legislative Oversight

From: Charles M. Bernardo, Superintendent of Schools CMB

Subject: Legislative Oversight Report #78-3, Failure of Some School Roofs

The opportunity to examine and comment on a draft copy of your Report #78-3 on roof failures, transmitted with your March 3 memorandum, is appreciated. We have no suggestions for change.

Your report is very thorough in dealing with all aspects of complications surrounding industry-wide problems with roofs. I believe our staff has learned much as a result of these relatively isolated failures of some roofs constructed in the late 1960's and early 1970's. As you recommend, our staff will be pleased to cooperate with persons from other agencies as pertinent information is shared.

We will continue to participate in further studies you are requested to undertake by the County Council. By copy of this memorandum to Mr. Wilder, I will request that he bring the contents of this report to the awareness of those persons on his staff who are involved with roof construction and maintenance.

CMB:hc

INSPECTION FORMAT: ANNUAL INSPECTION OF BUILT-UP ROOFS

BUILDING NO. _____ DATE OF INSPECTION _____

Roofing Membrane

General Appearance: Good _____ Fair _____ Poor _____

Water Tightness: No leaks _____ Leaks with long-continued rain _____
Leaks every rain _____

Reported Cause of Leaks: Weathering of roofing material _____
Faulty material _____ Faulty design _____ Faulty construction _____
Wind damage _____ Hail damage _____ Traffic on roof _____
Other mechanical damage (describe) _____
_____ Low spots (water ponding) _____
Failure of flashings _____ Failure of gravel stops _____
Other causes (describe) _____

Adhesion of Aggregate Surfacing to Bitumen: Good _____ Fair _____
Poor _____

Bare Areas: (Give approximate percentage of total roof area below)
Bituminous coating exposed[1] _____ Condition of coating:
Smooth _____ Alligatored _____ Cracked _____ Felt exposed _____
Felts disintegrated _____ Edges of felts curled _____ Blisters _____
(Give size range and approximate number per square if numerous) _____
_____
Cracked to allow water to enter: Yes _____ No _____
Buckles _____ Cracked to allow water to enter: Yes _____ No _____
Cracks in membrane _____ Through to roof deck: Yes _____ No _____
Fishmouths _____

General Condition of Roof Membrane: _____
_____

Treatment Recommended: _____
_____

Flashings:

Base Flashings:

Metal:

Deteriorated _____ Vertical joints open _____ Flanges of base metal flashing loose: Yes _____ No _____ Due to: Inadequate nailing _____ Not properly sealed with felt strips _____.

Plastic:

Sagged or separated from parapet wall _____ Buckled _____
Cracked _____ Failure of base flashing: Weathering _____
Mechanical _____ Surface coating disintegrated: Yes _____
No _____ Vertical laps not cemented properly: Yes _____ No _____

Cap Flashings:

Metal:

Firmly embedded into vertical wall: Yes _____ No _____
Deteriorated _____ Vertical joints open _____ Not covering base flashing adequately: Yes _____ No _____

Plastic:

Surface coating disintegrated _____ Flashing felt disintegrated _____

Flashing Reglet:

Groove pointed sufficiently: Yes _____ No _____
Recommended Treatment: _____
_____

Gravel Stop: Condition of Metals _____ Stripped in properly _____
Separated from roof membrane _____

[1] Surfaced roofs only

Drainage System (describe defects)

Roof drains _____

Scuppers _____

Gutters _____

Downspouts _____

Recommended Treatment: _____

_____

Parapet Walls:

Mortar joints deteriorated _____ **Settlement cracks in walls** _____

Joints in tile coping open _____ **Concrete coping cracked** _____

Other defects (describe) _____

Recommended Treatment: _____

_____

Source: Department of Defense Technical Manual, Facilities Engineering: Maintenance and Repair of Roofs, 1974.

Selective Bibliography

A. Griffen, C.W., Manual of Built-up Roof Systems, New York: McGraw-Hill Book Company, 1970.

B. General Services Administration, Roof and Waterproof Deck Systems Study, Research Report by Construction Consultants, Inc., 1970.

C. National Bureau of Standards Publications.

1. Building Science Series #9: Cullen, W. and Boone, T.H., Thermal-Shock Resistance for Built-up Membranes, 1967.

2. Building Science Series #19: Greenfield, Sidney H., A Study of the Variables Involved in the Saturating of Roofing Felts, 1969.

3. Building Science Series #23: Greenfield, Sidney H., Hail Resistance of Roofing Products, 1969.

4. Building Science Series #24: Greenfield, Sidney H., Natural Weathering of Mineral Stablized Asphalt Coatings on Organic Felt, 1969.

5. Building Science Series #55: Mathey, R.G. and Cullen, W.C., Preliminary Performance Criteria for Bitumenous Membrane Roofing, 1974.

6. Building Science Series #92: Rossiter, W.J. and Mathey, R.G., The Viscosities of Roofing Asphalts at Application Temperatures, 1976.

7. NBSIR #76-987: Rossiter, W.J. Jr. and Mathey, R.G., Effect of Insulation on the Surface Temperature of Roof Membranes, 1976.

8. NBSIR #77-1256: Mathey, R.G. and Rossiter, W.J., Jr., Properties of 21 Year Old Coal-Tar Pitch Roofing Membranes: A Comparison with NBS Preliminary Performance Criteria, 1977.

D. Department of Defense Technical Manual, Facilities Engineering: Maintenance and Repair of Roofs, 1974.

(Note: The above publications are on file at the Plant and Engineering Division of the Department of Facilities and Management.)

Office of Legislative Oversight

MONTGOMERY COUNTY, MARYLAND
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M E M O R A N D U M

June 20, 1978

TO: Elizabeth L. Scull, President, Montgomery County Council

FROM: Andrew Mansinne, Jr., Director, Office of Legislative Oversight

SUBJECT: Information on Roof Failures in Montgomery County Public Schools' and County Government Facilities

INTRODUCTION

1. On June 6, 1978, during a public hearing and subsequent discussion on an emergency supplemental appropriation for the Department of Facilities and Services, several issues were raised concerning the failure of some roofs of the Montgomery County Public Schools (MCPS) and the Public Service Training Academy (PSTA) roof. The specific issues raised concerned.

a. Specifications of MCPS school roofs which have failed and the the PSTA roof.
b. The limits of liability of the 20-year roof bond.
c. Matters relating to Office of Legislative Oversight Report 78-3.

2. Council President Scull directed an examination of these issues by the Director, Office of Legislative Oversight with a report submitted in accordance with Section 29A-7, Montgomery County Code, 1972, as amended by Chapter 18 of the laws of Montgomery County. This memorandum report will address the above issues and provide background and additional related information on roofing specifications, guarantees, bonds and current litigation. All information was obtained from original source documents and correspondence and interviews with official staff personnel, who have had an opportunity to comment on the report. A summary chart concerning County government and PSTA roof failures is attached to this memorandum report.

BACKGROUND

3. Council had noted a number of premature failures in built-up roofs on schools constructed in the late 1960's and early 1970's. There was also information that the County government had experienced roofing problems at the Public Service Training Academy. The Office of Legislative Oversight (OLO) conducted an evaluation of these premature roofing failures during the 2nd Quarter FY 78 using information developed in consultant's reports and in personal interviews with officials of those two agencies.

4. The OLO Report, 78-3, dated April 10, 1978, concluded that, although not the sole cause, premature failure of built-up roofing systems had been primarily caused by failure of the design, specifications, materials and workmanship associated with the two-ply coated felt roofing system.

5. The public hearing of June 6, 1978, on the emergency supplemental appropriation for the Department of Facilities and Services included $19,000 for design work for the PSTA roof reconstruction approved in the FY 79-84 CIP (Project #792345). The Department of Facilities and Services had expended the $19,000 from its FY 78 Operating Budget to complete the design work and be in a position to begin construction of a replacement roof in the summer of 1978. The emergency supplemental appropriation was requested and required to reimburse the operating budget for FY 78 under the premise that design funds appropriated in the FY 79-84 CIP would not be needed. Issues were raised concerning the roofing specifications and roof guarantee bonds for the PSTA and certain MCPS facilities and OLO Report 78-3. Those issues will be addressed in the remainder of this report.

PUBLIC SERVICE TRAINING ACADEMY ROOF

6. In 1969 the design contract for the PSTA was awarded to John S. Samperton. During design, the architectural firm became Chatelain, Samperton and Nolan (later to become Chatelain, Samperton and Carcaterra). Construction was during the period November 1971 to June 1974 by the general contractor Furman Builders, of Rockville. The built-up roof of approximately 68,000 square feet was installed by the roofing subcontractor H.T. Harrison and Sons, Inc. of Gaithersburg during the fall and winter of 1972-73. The specifications of the roof were:

"7B-02. Built-up roofing shall be "G.A.F.", "Barrett", "Koppers" or Philip Carey, 20-year tarred felt and pitch roof or asphalt with coated sheets, on insulated concrete and metal decks, as shown, carrying 20-year guarantee bond, installed in strict accordance with the manufacturer's specifications."

7. Two important items should be noted: a) The specification called for specific brand name roofing material and did not include an "or equal" clause to permit the contractor to substitute; b) The contract allowed substitution; however, for the contractor to substitute a roofing system other than the four specified would require a written request through the architect to the County, with appropriate credit to the County, and the written approval of the County.

8. The PSTA roof specifications also called for a vapor barrier:

"7B-06. Vapor barrier shall be Lexsuco, Carey Firechex or Reflecto-barrier, 004 inch thick sheet vinyl, or Sisalkraft vapor stop 298, and shall be applied to the metal deck directly under the rigid insulation board. Vapor barrier shall be labeled for U.L. construction no. 1 and Factory Mutual Laboratory class-1 rating."

However, during the initial construction of the roof it was discovered that the vapor barrier had been omitted over the metal decks. As a result, Change Order #11, dated February 28, 1973, changed the roofing specifications to omit the vapor barrier where the roof was applied over metal decks--with a credit to the County of $1,635.

9. The roofing material installed on the roof was a system consisting of three plies of #40 coated felt sheets manufactured by Bird and Sons, Inc. at an approximate cost of $93,000. There is no record that substitution of this non-specified brand was either requested by the contractor or approved by the architect or County. On or about August 28, 1974, a Bird and Sons Roof Guarantee Bond, with a flashing endorsement, as called for in the specifications, was executed in favor of the County for "a maximum aggregate liability" of $6,800 for period of twenty years. The bond guaranteed that Bird and Sons would

> "...at its own cost and expense, make or cause to be made any repairs that may become necessary by reason of ordinary wear and tear by the elements to maintain said roof...in watertight condition. (Any repairs in excess to such Amount of Guarantee [$6,800] shall be at the owner's expense)."

It should be noted that the limit of liability was 10¢ per square foot--$6,800 for 68,000 square feet--a normal amount for roof bonds during that time period. (An exception was the limit of liability for one school was only 5¢ square foot).

10. The bond carried six conditions, the major four being: requirement for written notification by the County to Bird and Sons when repairs were needed or when any alteration or opening was made to the roof; exclusion from liability for damage caused by windstorm, tornado, hurricane, lightening and hail; there could be no ponding of water on the roof; and Bird and Sons would "not be liable for repairs necessitated by faulty application of said roofing material."

11. The PSTA academic building was accepted by the County in June 1974. Under policies then in effect, the Office of Architectural Services would continue to be responsible for warranties for the time periods called for in the contract--normally one year; and the Office of Facilities Maintenance and Services would be responsible for maintenance. As early as March 4, 1975, Mr. James H. Payne, the County Building Maintenance Chief (Office of Facilities Maintenance and Services) notified H.T. Harrison in writing that "vast areas of the roof of the Public Service Training Academy are bubbling up." The following month, April 1975, the same maintenance chief notified the County's Office of Architectural Services that the roof contractor, H.T. Harrison, would correct bubbling on one section of the roof by the installation of roof vents. Ten vents were installed at no cost to the County. That same month, a representative of Bird and Sons inspected the roof subsequent to an inspection by a representative of the architect in March 1975. In July and August 1975, the Deputy Director, DCED, officially notified the architect, Mr. Samperton, and Furman Builders' representative, Mr. Cubitt, of the condition of the roof.

12. The early problems with the PSTA roof concerned bubbling and soft spots, caused by entrapped moisture, and ponding and their potential detrimental effect on the 20-year life of the roof. However, in late 1975, the problem of water leaking through the roof was discovered. There followed more correspondence between the County, the architect and the contractors. In April 1976, an outside consultant, with a representative of Bird and Sons present, took samples of various sections of the roof. The consultant's report of May 21, 1976, concluded and recommended:

"CONCLUSIONS

1. Blistering of the roof membrane is caused by moisture entrapped between the plies during application.
2. The roof membrane applied does not comply with the project specifications.
3. Omission of a vapor barrier over the metal deck does not comply with the project specifications. [Change Order #11 permitted omission]
4. The flashings at the skydomes do not comply with the project drawings."

"RECOMMENDATIONS

Remove all roofing, insulation and base flashings and install new insulation, a 20-year type aggregate surfaced membrane and bituminous base flashings."

13. Since March 1975, the County has attempted through negotiations to permanently resolve the PSTA roofing problem. Logs indicate that H.T. Harrison made repairs to sections of the roof at no cost to the County--but failed to correct the leaking roof. Finally, the County government decided to take steps through the CIP process to replace the roof at an estimated cost of construction of $250,000. Design for a new roof has been contracted at a cost of $19,000. Solicitation of bids will be sent out shortly with bid opening scheduled for July 14, 1978. In addition, in July 1977, the County initiated litigation against the architect--Samperton, the contractor--Furman Builders, the consulting engineers--Youssef and Associates, the roof sub-contractor--H.T. Harrison, and the performace bond Surety--the Hanover Insurance Company, for $500,000 damages in connection with PSTA design and construction problems associated with the roof and the firing ranges. *The County's declaration also included a demand for judgment against Bird and Sons for the amount of the roof guarantee bond--$6,800. However, the Circuit Court on February 14, 1978, granted a motion for Summary Judgment in favor of Bird and Sons, which denies the County monetary damages on the basis of the roof guarantee bond.

*Note: This July 1977, action was an amended declaration to an original declaration which was filed by the County in September 1976.

14. Conclusions relating to PSTA roofing system failure.

a. The Bird and Sons roof installed at the PSTA was not one of the four systems listed in the project specifications.

b. There is no record in the County files that substitution of the Bird and Sons roofing system was approved by the architect and County.

c. A 20-year roof guarantee bond was executed on the Bird and Sons system guaranteeing repairs necessitated by ordinary wear and tear to a maximum aggregate liability of $6,800, or 10¢ a square foot.

d. Roof problems in the form of bubbling, soft spots and ponding were discovered eight months after the County accepted the building; with leaks developing a little over a year after accepting the building.

e. When roofing problems were discovered, the County immediately initiated procedures to have the contractor correct the problems under the 20-year roof guarantee bond.

f. After three years of negotiations, correspondence, an analysis by an independent consultant, and attempts by the roofing subcontractor to make repairs to the roof (at no cost to the County) the County initiated litigation against the principals to seek $500,000 in damages for design and construction problems.

ROOF FAILURES IN THE MONTGOMERY COUNTY PUBLIC SCHOOLS

15. In the late 1960's and early 1970's MCPS constructed fifteen schools or additions to schools on which a two-ply, coated felt built-up roof was installed. As of this date, eight of those roofs have failed, resulting in water leaking into the interior of the schools. Six of the eight schools have been repaired by re-roofing over the original roof.

16. The specifications for construction of each of the fifteen projects on which a two-ply roof was installed did not call for the two-ply roofing system. The general specifications provided for substitution of an "equal" product with credit to MCPS provided the substitution was approved in writing by the architect and MCPS. With one exception there are no records in MCPS files approving substitution of the specified three (or more)-ply systems with the two-ply coated felt system which was actually installed. The one exception is in the case of Saddlebrook Elementary School where MCPS records reflect that the architect approved substitution of a two-ply roof. As explained in OLO Report 78-3, a two-ply roof system is: "A roof which has at least two plies of coated felt at any vertical cross section cut through the membrane. Utilizes felt which is coated with asphalt at the factory and coated with more asphalt at time of installation." At the time the two-ply roofs were being installed on MCPS facilities, roofing manufacturers were "pushing" the two-ply system as a breakthrough in efficient, waterproof roofing systems. Within the MCPS files is a July 1970 letter from the architect for one of the schools, Argyle Junior High. A two-ply coated felt roof was installed on Argyle and it is one of seven two-ply systems which has not developed problems. In that letter, MCPS was advised, that "...the movement away from four-ply standard asphalt-felts is industry-wide and that it is

very difficult to get a four-ply roof bonded." (The two-ply roofing system was bondable for 20 years as required by MCPS specifications). The letter concluded that "...the current trend to two-ply coated felt system is a superior one for the very basic reason that it goes a long way toward eliminating...moisture absorption and entrapment before and during [roof] construction. Thus, it was the professional opinion of at least one architect that the two-ply system was at least equivalent if not superior to other multiply systems. MCPS records reveal no evidence that MCPS approved or objected to installing the two-ply systems rather than the specified three (or more)--ply roofing systems.

17. For each two-ply roofing system, a 20-year roof bond, with a roof flashing endorsement, was executed--usually at a limit of liability of 10¢ per square foot. As in the case of the PSTA bond, the roofing bond covered repairs only up to the limit of liability (examples: $3,500 for 35,000 sq. ft. of original roofing on Gaithersburg High Auditorium; and $8,410 for 84,100 sq. ft. of original roofing on Robert Frost Jr. High); and covered repairs required "...soley from ordinary wear and tear by the elements...". Each bond had a number of conditions releasing the roofing system manufacturer from liability, the major ones being: severe weather or other unusual phenomena and errors or negligence in construction of the building or installation of the roof.

18. The MCPS has received various repairs to faulty roofs under some of the bonds. As an example, the GAF Corporation authorized repairs to the Gaithersburg High Auditorium roof in excess of the $3,500 limit of the GAF roof bond. MCPS has attempted to obtain full satisfaction for the failed roofs through negotiations, correspondence, and, as in the case of the PSTA, an analysis of one of the failed roofing systems by an independent consultant. A consultant analyzed the Robert Frost Jr. High roof in June 1977, and made the following conclusions:

a) "Water is entering through splits in the roofing membrane and broken blisters."
b) "Selection or approval of a two-ply roofing system that is inadequate for the purpose because of its weakness and its tendency to blister...[and]...failure to provide expansion or relief joints at changes in direction of the deck and at re-entrant corners..." (Design defects).
c) "Water was built into the system..." (Material defect).
d) "If the workmanship used in the installation of this roofing system had been without fault, we would still expect some leakage due to the design defects listed. If the design work had been without fault, we would still expect the roofing system to fail due to the materials or workmanship used in its construction."

19. At present, six of the schools have been repaired by re-roofing over the original roof at a cost to MCPS of approximately $300,000. In each instance, re-roofing has been with a three (or more)-ply system. Plans are currently being made to re-roof the remaining two schools.

20. In early June 1978, the MCPS staff met with the principals concerned with the design, construction, installation and material manufacture of the roofing systems which have failed in an attempt to reach a mutually satisfactory settlement. Failure of this latest attempt will, according to MCPS staff personnel, necessitate MCPS taking the issue to litigation.

21. Conclusions relating to MCPS roofing system failures:

a. The two-ply roofing systems installed on the eight school roofs which have failed were not the roofing systems specified in the projects' original specifications.

b. With one exception, Saddlebrook Elementary, there is no written record in the MCPS files that substitutions of the two-ply coated felt systems on roofs which failed were approved by the architect.

c. There is no written record in the MCPS files that substitutions of the two-ply coated felt systems on roofs which failed were approved by MCPS.

d. Twenty-year roof bonds were purchased from the manufacturers of the roofs for each of the two-ply roofing systems guaranteeing repairs necessitated by reason of ordinary wear and tear to a maximum liability limit of 10¢ per square foot for all schools but one, Wayside Elementary, where the limit was 5¢ per square foot.

e. Leaks in the roofing systems were experienced and reported subsequent to MCPS utilizing the school facilities.

f. When roofing leaks were discovered, efforts were made by MCPS personnel to contact the various parties involved in the original construction of the roofs, including the manufacturing companies who issued the bonds, to have roofs examined and repaired. Various roof repairs were made at no cost to MCPS--in one instance to the limit of the liability under the 20-year bond.

g. The MCPS staff has been attempting to resolve the roofing problems through negotiations with the principals. It appears that MCPS intends to seek litigation to recover damages for the roofing systems failures.

MATTERS RELATING TO OFFICE OF LEGISLATIVE OVERSIGHT (OLO) REPORT 78-3, SCHOOL ROOFS (SHORT TITLE).

22. At the June 6, 1978, public hearing on the Department of Facilities and Services' supplemental appropriation, matters were alleged concerning inaccuracies in OLO Report 78-3. A review of testimony and the report confirms that OLO Report 78-3 incorrectly stated in paragraph 10 that the PSTA roof is a two-ply system. Actually, the PSTA is a three-ply system consisting of coated felt sheets of the type used in the coated felt two-ply roofing systems.

OTHER RELATED MATTERS

23. General: Three other related matters are considered germane to the problem of premature failure of built-up roofing systems in facilities belonging to the County government and the Montgomery County Public Schools. These matters are listed below and discussed in subsequent paragraphs:

a. Performance Bond, Labor and Material Payment Bond and other guarantees.
b. Current roofing system guarantee policies.
c. The Department of Facilities and Services organizational changes.

24. Guarantees. For both County government and MCPS construction projects, several guarantee bonds are required.

a. Bid Bond. A bid security in a required form and amount is required from each bidder pledging that the bidder will enter into a contract with the owner (County, MCPS) if selected. The bid security may be in the form of a cashiers check or security company bond. For County government construction bids, the normal amount of the bid bond is 5% of the bid and, if forfeited to the County, would be as liquidated damages, not as a penalty. For MCPS, the normal bid bond is 10% of the bid.

b. Performance and Labor and Material Payment Bonds. State and County law require a Performance and a Labor and Material Payment Bond, in favor of the County, to cover 100% of the total contract. The Performance Bond is to guarantee faithful completion of the contract. The Labor and Material Payment Bond, issued simultaneously with and in the same amount as the Performance Bond, is to guarantee payment of either labor or material claims against the contractor. The premium for these bonds are paid by the successful bidder; however, the premium cost is passed on to the owner in the bid.

c. Other guarantees. County agencies may require other bonds, warranties and guarantees on particular parts or equipment in a construction project. The roof guarantee described earlier in this report is one example. Other examples would be manufacturer's warranties and guarantees on mechanical equipment (compressors and motors), boilers, elevators, etc.

25. Current Roofing System Guarantee Policies.

a. For recent projects, the County government and MCPS have not required 20-year roof bonds, as experience has indicated that they are costly, have limited liability and specify too many conditions. In place of the 20-year bond a variety of guarantees and warranties are used. For a new type roofing system called an Insulated Roof-Membrane Assembly, installed on the Liquor Warehouse, Long Branch Library and the new DOT Up-County maintenance facility, DOW Chemical issued a one-source 10-year guarantee on material and workmanship. The warranty guarantees that if the roof does not remain water tight "...Dow will, at its own expense, cause to be made the repairs or modifications to the roof to the extent necessary to enable the roof to perform as warranted".

b. Specifications for the new Montgomery County Government Center call for a roof guarantee bond of not less that $20.00 per 100 sq. ft.--double the liability of past bonds. However, the Department of Facilities and Services is considering not taking out a bond on the roofing system. This decision will be made at a later date.

c. For recently constructed new and replacement roofs, MCPS requires a 5-year written guarantee from the roofing contractor that the roof will perform as specified.

d. Specifications for the built-up roof on the new addition to the Maryland National Capital Park and Planning Commission offices on Georgia Avenue call for a two year written guarantee.

e. Specifications for the built up roofing system being installed on Montgomery College facilities at the Germantown Campus call for a 5-year written guarantee.

26. The Department of Facilities and Services Organizational Changes.

In the opinion of this writer, the reorganization which created the Department of Facilities and Services will facilitate the County government's coordination and control of construction projects from pre-design through post-construction "shake-down" to normal operational maintenance. At the time of the PSTA project, responsibilities were divided between the Office of Architectural Services in DCED and the Office of Facilities Maintenance and Services. Under the new organization, the Director of Facilities and Services is responsible for the total project--design, construction and operational maintenance through the life of the facility.

SUMMARY

27. In the late 1960's and early 1970's, changes were made to project specifications on at least fifteen Montgomery County Public Schools' roofing systems which substituted a two-ply coated felt built-up roofing system for the specified three (or more)-ply systems. There was no evidence in MCPS files that MCPS approved or objected to the substitution of the two-ply roofing system. To date, over half of these two-ply systems have prematurely failed.

28. The Bird and Sons three-ply coated felt built-up roofing system installed on the Public Service Training Academy during the fall and winter of 1972-73 did not comply with the project's roof specifications and there are no records in the County's files that substitution of the Bird and Sons roofing system was approved. The PSTA roof has also failed and will require replacement.

29. For each of the MCPS facilities and PSTA roof, a 20-year limited liability roof bond for ordinary wear and tear was issued. Although testimony at the June 6, 1978, public hearing correctly reflected that the normal roof bonds were for 20 years; the testimony was not accurate when inferring that roof bonds had unlimited liability

for the 20-year period. The roofing bond's normal limit of liability was 10¢ a square foot with any repairs in excess of that amount being at the owner's expense. If the limit of liability of a roof bond was reached at some period short of the 20 year life of the bond, as was the case of Gaithersburg High School Auditorium, the bond would no longer be applicable.

30. Because of the cost of roof bonds, their limited liability and numerous conditions, County agencies are presently not requiring bonds, substituting instead manufacture/contractor warranties and guarantees.

31. Contrary to testimony at the public hearing, the MCPS and the County government initiated procedures to have the bonding companies and contractors correct roofing problems under the 20-year roof guaranteeing bonds. MCPS and County government have received various roof repairs under these guarantees.

32. The County government is currently demanding through litigation damages from the principals associated with the PSTA project. Apparently, MCPS intends to recover damages through litigation.

AM:cls

Attachment

cc: County Council
County Executive
Chief Administrative Officer
Director, Facilities and Services
Director, Budget and Research
Director, Management and Public Policy
County Attorney
Superintendent, Montgomery County Public Schools
Director, Department of School Facilities
Director, Division of Construction
MNCPPC, Attn: Mr. Alan Lemke
Montgomery College, Attn: Director of College Facilities
Mr. Robert McDonell
Mr. Athlyn B. Waller

SUMMARY DATA ON PREMATURE ROOFING SYSTEM FAILURES

	COUNTY GOV'T	MCPS							
	PSTA	Saddlebrook Elem.	Tuckerman Elem.	Stonegate Elem.	Wayside Elem. (original)	Robert Frost Jr. High	Gaithersburg High Auditor.	Cashell Elem.	Blair High Auditor.
Architect	Chatelain, Samperton & Carcaterra	J. Lawrence now Lawrence and Grimm	B. Meyers	E.A. Delmar	E.A. Delmar	P.W. Mason consigned to Johannes & Murray	S.H. Arthur	Cohen & Haft	Johannes & Murray
General Contractor	Furman Builders	G. Parker and Sons	G. Parker and Sons	Robert J. Menley	Glenn Const. Co.	Equitable Const. Co.	Clark & Chapman	Blatzheim & Beall	Coleman & Wood
Roofing Contractor & Roof Ply	H.T. Harrison 3-ply	H.T.Harrison 2-ply	H.T.Harrison 2-ply	H.T.Harrison 2-ply	N.D.Bean 2-ply	H.T.Harrison 2-ply	H.T. Harrison 2-ply	H.T.Harrison 2-ply	H.T.Harrison,2-ply
Performance & Payment Bonding Company	Hanover Insurance Co.	Peerless Ins. Co.-Keens,NH	Peerless Ins. Co.	Hanover Ins. Co.-NY, NY	Reliance Ins. Co.-Phila, PA	Aetna Casualty & Surety Co.	Hanover Ins. Co.	Reliance Ins. Co.	St. Paul Fire & Marine Ins. Co.
Roof Bonding Co. & Bond Number	Bird & Son,Inc. 20J-P-B/U 5637-F	GAF Corp. (unk)	GAF Corp. B-10616	GAF Corp. (unk)	Certain-Teed #15923	GAF Corp. #B-10662	GAF Corp. #B-10742	GAF Corp. #B-10367	GAF Corp. #B-10477
Approx. Date Orig. Roof Installed	10/72 to 2/73	5/7/70 to 6/11/70	5/70	1/20/71 to 4/23/71	2/21/69 to 3/28/69	8/12/70 to 11/10/70	7/21/69 to 8/24/69	5/16/69 to 6/10/69	3/69 to 4/69
Date Accepted Project	6/74	11/10/70	11/10/70	9/27/71	9/22/69	7/26/71	3/27/72	11/14/69	1/26/70
Approx. Date Roof Replaced	Pending	9/75	8/76	9/76	9/76	9/77	9/77	Pending	Pending
Reroofing Contractor	Pending	Virginia Roofing Co.	Colbert Enterprises	Orndorff & Spaid	Orndorff & Spaid	Colbert Enterprises	Orndorff & Spaid	Pending	Pending
Size & Cost of Reroofing (see note a)	Pending (Est. 68,000 Sq.Ft. $250,000	38,100 sq.ft. $43,643	44,600sq.ft. $49,936	34,400sq.ft. $36,000	39,800sq.ft. $51,071	78,800sq.ft. $83,878	32,600sq.ft. $36,000	Pending	Pending

Note a. For reroofing the six completed schools, specifications included coverboard over old roof, insulation, 3-plies of built-up roofing felts, flashing and other necessary metal work.

Attachment to Office of Legislative Oversight
Memorandum Report, June 20, 1978.

Data Assembled:
June, 1978