The impact of sick building syndrome on selected variables associated with school effectiveness

Caryl Shannon Felty
College of William & Mary - School of Education

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THE IMPACT OF SICK BUILDING SYNDROME ON
SELECTED VARIABLES ASSOCIATED WITH
SCHOOL EFFECTIVENESS

A Dissertation
Presented to
The Faculty of the School of Education
The College of William and Mary in Virginia

In Partial Fulfillment
Of the Requirements for the Degree
Doctor of Education

by
Caryl Shannon Felty
April 1996
THE IMPACT OF SICK BUILDING SYNDROME ON
SELECTED VARIABLES ASSOCIATED WITH
SCHOOL EFFECTIVENESS

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THE IMPACT OF SICK BUILDING SYNDROME
ON SELECTED VARIABLES ASSOCIATED WITH
SCHOOL EFFECTIVENESS

ABSTRACT

Using matched pairs of schools having a diagnosis of Sick Building Syndrome (SBS) and those not identified, and not having the potential of being identified as having the diagnosis, this study examined the relationship between factors assumed or determined to have an impact on a school's ability to carry out its mission as they related to the SBS diagnosis. The factors studied were student average daily attendance (ADA); students' mean standardized test scores in math and reading on the Iowa Test of Basic Skills and the Tests of Achievement and Proficiency; the need for students to take prophylactic medications; the rate of staff turnover; the percentages of short term suspensions (less than 10 days), long term suspensions (more than 10 days), and the percentage of recommendations for expulsion; as well as the impact of the public identification of a school as having a diagnosis of SBS on student ADA, mean standardized test scores in math and reading and staff turnover. A factorial ANOVA model (2 by 4) for repeated measures revealed no statistical significance for main or interaction effects on any of the six hypotheses addressed.

CARYL SHANNON FELTY

SCHOOL OF EDUCATION

THE COLLEGE OF WILLIAM AND MARY IN VIRGINIA
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THE IMPACT OF SICK BUILDING SYNDROME ON
THE EDUCATION OF TODAY’S YOUTH
The Impact of Sick Building Syndrome on
The Education of Today's Youth

Introduction

Newspaper accounts of Sick Building Syndrome often read like something out of Edgar Allen Poe - descriptions of sudden illnesses in which the victims suffer a sense of suffocation, strange headaches, nausea, reports of mysterious odors, speculations about poisoned air. Complaints that office workers are threatened by strange diseases are alarming, but when these symptoms appear in school children and teachers, the voices of concern become an outcry.

Are we looking at a new plague, ominously adapted to a society in which people spend as much as 90% of their time indoors? Do we have a contemporary example of mass hysteria? Is it just the latest exaggeration by the press? Perhaps it's a little bit of all of these.

Despite the uproar, sick building syndrome remains a confusing, imperfectly understood phenomenon (Reecer, 1988, p.17).

The energy crisis of the 1970's resulted in school buildings being sealed and new facilities being built, the designs of which reflected the need to conserve resources. According to many, an even greater crisis may have been created; a crisis that daily threatens the health of an untold number of workers as well as the health of school children.
As with most crises, the greatest enemies are time and money. Time is needed to define the problem, diagnose the ills, determine the remedies and legislate against the possibility of repeating errors. Money is needed to undo twenty or more years of effort toward conserving energy and resources through, what was thought to be, creative construction and re-construction. The actual cost in dollars and human resources may never be known.

The term "Sick Building Syndrome" (SBS) is an import from Scandinavia. The problem, apparently, is a legacy of the energy crisis of the 1970's and results mainly from tightly sealed, poorly ventilated buildings with low or background levels of pollutants, often from inside the buildings. But researchers have also found problems with temperature and humidity levels. Sick buildings frequently have windows that do not open, and many suffer from the kind of problem in design, use, or maintenance of their heating, ventilating and air-conditioning systems that leads to insufficient supplies of fresh air (Reecer, 1988, p.17).

The Environmental Protection Agency's (EPA) Indoor Air Quality (IAQ) condition seems to fit a proposed definition of SBS:

According to industry IAQ Standards, sick building syndrome is diagnosed if "significantly more than 20% of a building's occupants complain of such symptoms as headaches, eye irritation, fatigue and dizziness for more than two weeks, the symptoms are relieved when the complainant leaves the building, and no specific cause of the problem can be identified" (Gardner, 1991, p.30).
An SBS condition can be caused by failure to introduce a sufficient amount of ventilation (outside air flow rate) into the interior of a building. The ventilation air flow rate is the amount of air brought into a building by the supply air flow fan from outside the occupied space. Indoor air pollution generally increases when the ventilation air flow rate falls below design conditions.

Almost any large building that is air-conditioned will have characteristics of a sick building at some time. In other words, sick building syndrome, chronic in some buildings, will be episodic in many. Schools are more likely to be susceptible because they are notoriously low on funds; which in turn means regular maintenance of ventilating equipment might not be a top priority (Reecer, 1988, p. 18).

Once children begin experiencing symptoms, parents and school officials will likely find themselves in tension and conflict. If nothing is done, the problem often becomes a legal issue. School Boards may then emphatically deny any harmful exposures for fear of being held financially liable to a whole school population; especially since insurance policies almost always exclude pollution related claims (Green, 1992, p. 35). Anticipating such problems, Maryland’s State Department of Education started a unique, impressive indoor air program. Thus far, the department has provided testing equipment, published materials, created an indoor air management program and offered workshops for teachers and administrators to learn how to spot indoor air problems (Green, 1992, p. 35).

Sick Building Syndrome is a problem that clearly exists in America’s schools. The question remains as to whether or not schools that have sick building
characteristics have a negative impact on the ability of the staff to teach and the children to learn.

Basis for the Study

Popular news magazines have capitalized on the public’s interest in the phenomenon known as Sick Building Syndrome. No search is without numerous references to readily available print media on the subject. It is difficult to pass any newsstand without some article concerning the topic catching one’s eye. A search of a single research data base revealed over two hundred references on SBS. Sick Building Syndrome is a topic for which there is much current curiosity and interest.

The 1992 identification, and subsequent publication of its sick school buildings, by a Virginia school division resulted in heightened levels of anxiety among the publics served through these facilities. The study requested by the School Board of Dr. James Woods and The Virginia Polytechnic Institute, "and leading expert on 'sick' buildings," (Fagan, 1995) gave credence to the concerns. In some instances, the concerns bordered on hysteria and resulted in the issuing of ultimatums by individual families who felt their offspring were in jeopardy. Clearly there was a need to determine if, in fact, there was a negative causal relationship between Sick Building Syndrome and an individual school’s ability to carry out its mission of teaching and learning.

Need for the Study

A national survey conducted by the Educational Research Service of 2,418 elementary and secondary school administrators brought forth 922 usable responses
which indicated that "one building in every eight is an inadequate place for learning" (Hansen, 1989, p. 19). David Hornbeck, State Superintendent of Schools in Maryland, said that "Less than adequate indoor air quality can lead to a higher risk of health problems, an increase in student and teacher absenteeism, diminished learning, and in extreme situations, a hazardous condition" (Green, 1992, p. 31). The National Academy of Sciences now believes that 15 - 20% of the population shows symptoms of chemical sensitivity that makes them particularly vulnerable to sick buildings. "Children are at greater risk than adults because they have fewer detoxifying enzymes, breathe more air for their body weight, absorb toxic chemicals more readily, and have cells that divide more rapidly, making them more prone to cancer. Moreover, there are no regulatory standards for indoor contaminant levels for children in schools, and acceptable risks are based on theoretical effects upon an average-sized adult" (Green, 1992, p. 31).

A clear connection between poor ventilation and disease was made only recently. In a four year study published in 1988, the Walter Reed Army Institute of Research in Washington, D.C., tracked the respiratory health of recruits at four separate Army training centers. The study is notable because the subjects were a highly controlled group: they were drawn randomly from all over the country; they all received identical immunizations during processing; the soldiers in one barracks tended not to have contact with those in another; and at each camp, the soldiers did the same activities outdoors under the same conditions. Indoors, however, some soldiers lived in energy-efficient barracks and some lived in open window barracks.
At each camp, the incidence of acute respiratory disease was at least 45% higher in the energy-efficient barracks (Laliberte, 1990, p. 64).

Most investigations by the National Institute of Occupational Safety and Health (NIOSH) could attribute IAQ problems only to poor ventilation. Simon Turner, technical consultant at Healthy Buildings International, Inc., of Fairfax, Virginia says, "A properly designed and operated ventilation system should be able to handle most indoor troublemakers. Such a system includes adequate amounts of outside air and clean vents and air ducts. You wouldn't believe what we find inside air ducts; inch high layers of dust, microbial slime, dead rats and snakes, lunch packets left by workers. It's the ideal breeding ground for bacterial fungi; an enclosed, dark, controlled environment. If we can fix those problems, I say 90% of air quality problems in this country will be solved" (Laliberte, 1990, p. 65).

Bacteriologist, Gary Robertson’s company, ACVA Atlantic, Inc., based in Fairfax, Virginia, has investigated the indoor air quality in more than 40 million square feet of business space; including landmarks such as Scotland Yard and the Supreme Court. What he discovered was appalling to him. Robertson saw buildings so heavily polluted with fungal spores, bacteria and other contaminants that the employees worked in a constant state of fatigue. He found offices in which he determined people’s lungs were the only filtering devices (Epstein, 1988, p. 1H).

A five year study by the U.S. Environmental Protection Agency found, "The air in our homes and workplaces is always three to five times more polluted than the
worst exterior air, and may even be as 100 times more polluted" (Epstein, 1988, p. 2H).

Some children have already become sick from their schools. At Western Primary School in Indiana, 50 out of 170 students began coughing up "black stuff" and suffering from recurring bronchitis and extreme fatigue. West Virginia's East Fairmont High School students and teachers experienced twitching eyes, rashes, headaches, heart palpitations and tremors. Andrew Jackson High School, also in West Virginia, was shut down in May of 1989 by the National Institute of Occupational Safety and Health (NIOSH) following four years of complaints by students and teachers of persistent fatigue, headaches, respiratory problems, nausea, and numbness in the limbs (Green, 1992, p. 33). Teachers and students at Marcus Hook Elementary School in Pennsylvania had symptoms of hoarseness, smarting eyes, a facial flush and nausea (Reecer, 1988, p. 18). A rash of lung, skin, and eye ailments that struck workers at the University of Florida's Veterinary College in 1987 was bad enough to force the evacuation of the building (Epstein, 1988, p. 2H).

Poor indoor air quality, or sick school syndrome, has now moved into the public eye. The National PTA has noted the problem and has taken a stand on behalf of the students for whom it advocates. In its 1994-95 package of legislative directives under Environmental Health Hazards: Health and Welfare, #5, the text reads:

The National PTA supports:

a) legislation and regulations to manage or eliminate environmental health hazards such as asbestos, radon, lead and pesticides that are present in schools and child care
facilities, with special emphasis on protecting children and employees and formally
notifying parents;

b) federal laws and regulations to reduce toxic residues on agricultural products;

c) legislative efforts to improve air quality, particularly as it affects children; and
d) comprehensive childhood lead poisoning legislation [PTA 1993-1994, p. 3].

Michael McCann of the Center for Occupational Hazards notes that "children
are also at high risk because of their low weight, incompletely developed body
defenses, rapidly growing body tissues which are easily damaged by toxic exposure or
lack of oxygen, and small lung passages which are susceptible to inflammations and
spasms" (Miller, 1993, p.29). That which may have little or no negative effect on
adults may be seriously damaging to the children.

With one person in every six in this country suffering from some kind of
allergic health problem, and hay fever, and asthma alone causing children to miss 130
million school days each year (Miller, 1993, p. 30), the need for this study is
apparent. It is obvious that improved [indoor] air quality means improved health,
which, in turn, means improved attendance and learning (Miller, 1993, p. 30).

Justification for the Study

The literature clearly indicated that sick building syndrome is a reality. It also
included school buildings in the category of buildings which commonly suffer from
the syndrome. It further asserted that young people may be more vulnerable to the
negative effects of working in a building identified as "sick." It follows that Sick
Building Syndrome may have a negative impact on a teacher's ability to teach, a student's ability to learn, and therefore, a school's ability to carry out its mission.

Although there are many reasons for a diagnosis of SBS, this study was limited to those associated directly with Heating, Ventilation, and Air-Conditioning (HVAC) systems.

Purpose of the Study

The purpose of this study was to determine if schools identified as having "Sick Building Syndrome" were different from those not identified as being "sick" on selected characteristics.

Research Question

Does poor indoor air quality or "Sick Building [School] Syndrome," negatively affect a school's ability to carry out its mission?

Research Hypotheses

1. The percentage of staff absences in schools having a diagnosis of SBS will be significantly greater than the percentage of staff absences in schools which were not identified as being "sick."

2. The average daily attendance (ADA) in schools having a diagnosis of SBS will be significantly lower than the ADA in schools which were not identified as being "sick."

3. Students' mean standardized test scores for reading and math in schools having a diagnosis of SBS will be significantly lower than students' mean standardized test scores for reading and math in schools which were not identified as being "sick."
4. There will be a significantly greater percentage of students taking prophylactic medications in schools diagnosed as having SBS than the percentage of students taking prophylactic medications in schools which were not identified as being "sick."

5. The percentage of staff turnover in schools having a diagnosis of SBS will be significantly greater than the percentage of staff turnover in schools which were not identified as being "sick."

6. There will be a significantly greater percentage of behavior referrals for administrative intervention in schools having a diagnosis of SBS than the percentage of behavior referrals for administrative intervention in schools which were not identified as being "sick."

7. There will be a significantly higher percentage of suspensions and recommendations for expulsion in schools having a diagnosis of SBS than the percentage of suspensions and recommendations for expulsion in schools which were not identified as being "sick."

8. In schools having a diagnosis of SBS, staff attendance, student ADA and students’ mean standardized test scores for reading and math will show a significant decrease while staff turnover will show a significant increase following the public announcement that a school has been identified as being "sick."

Operational Definitions

Sick Building Syndrome (SBS):

Sick building syndrome exists when more than 20% of a building’s occupants complain of such symptoms as headaches, eye irritation, fatigue and dizziness for
more than two weeks. The symptoms are relieved when the complainant leaves the building and no specific cause of the problem can be identified (Gardner, 1991, p. 30).

**Sick Schools:**

For the purposes of this study, a Virginia school division's buildings identified as having SBS were those which had been investigated by Dr. James Woods of Virginia Polytechnic Institute. Dr. Woods is a leading expert on "sick" buildings (Fagan, 1995). A more detailed account of his qualifications may be found in the Appendix of this document. The "sick" schools were publicly identified in November of 1992 by the school division. For these eight schools, the entire building was identified as being "sick."

**Schools Not Identified as Being "Sick":**

For the purposes of this study, an equivalent number of public schools from the same Virginia school division that were built prior to 1975 and had not undergone a major energy efficiency renovation, were matched for criteria such as free/reduced lunch eligibilities, mobility index, instructional level, and ethnic balance. These schools had not been labeled by the school division as being "sick" and were studied as "schools not identified as being sick."

**Staff Absences:**

Staff absences were documented sick leave as reported through the schools to the payroll office. These data were unobtainable by school for the years studied
because as staff members transferred within the city, their data bases followed them.

Year-end reports were not maintained in either tape or hard-copy formats.

**Student Absences:**

Student absences were documented absences from schools as reflected on the Columbia Student Data Base. Prior to the 1992-93 school year, this information came from the EPIC Student Data Base.

**Students' Standardized Test Scores:**

Students' standardized test scores were those mean scores obtained on the standardized tests authorized through the Virginia State Assessment Program (Iowa Tests of Basic Skills/ITBS and the Tests of Achievement and Proficiency/TAP). Trends in declines and improvements for mean scores over a four year period were evaluated in the matched pairs of schools.

**Prophylactic Medications:**

Prophylactic Medications are those medications which guard or protect against disease or conditions. For the purpose of this study, they were limited to medications for ADD/ADHD, asthma, and other upper respiratory conditions.

**Rate of Staff Turnover:**

The rate of staff turnover was defined as the percentage of new staff to a given building each school year. These data were examined over the defined four year period.
Behavior Referrals:

Behavior Referrals were formal referrals to the administrative office of a school using form IS-8-30-89 where intervention was sought for a violation of the selected school division’s Code of Student Conduct. These data were inconsistent and, therefore, unusable. There was no uniform method of recording these data among the schools for the years studied. Disciplinary records followed the student in hard copy format with no cumulative data being maintained consistently in a school data base. This procedure changed with the onset of the 1995-96 school year.

Rate of Suspension and Recommendation for Expulsion:

The rate of suspension and recommendation for expulsion was derived from the selected school division’s Office of Student Services. All students reflected in these data violated offenses on the list of offenses for which a suspension or an expulsion recommendation must occur. This list is found in the citywide Code of Student Conduct.

Research Design

This study implemented a causal comparative design in an effort to examine and compare eight schools from a selected Virginia school division identified as having Sick Building Syndrome with an equivalent number of matched schools from the same division which were neither identified as being "sick" nor had a known potential for the SBS diagnosis. Outcome measures were limited to:

1. staff absences (usable data not available)
2. student absences
3. students' mean standardized test scores for reading and math
4. the need for prophylactic medications
5. staff turnover
6. behavior referrals for administrative intervention (usable data not available)
7. rates of suspensions and recommendations for expulsion
8. changes in data from (1), 2, 3, and 5 above, following the public announcement of school buildings identified as "sick"

Eight Virginia public schools from a selected school division identified as having SBS were matched with an equivalent number of schools not diagnosed and not having the potential of being diagnosed as having SBS. Attention was given to match the schools in an effort to rule out such potentially spurious factors as socioeconomic level, student turnover, and instruction level (elementary, middle, and high school).

Any of the research hypotheses factors could have been related to something other than SBS. It was assumed that any other relationship to the presence of a non-SBS factor would be typical across the population. Any significant differences could then have been logically attributed to the independent variable: the presence of an SBS diagnosis.

The 1991-1995 division superintendent for the selected school division gave permission for the study. The School Board for the selected school division granted authorization.
Data Collection

All data were historical in nature. The sources for the various categories were as follows:

Hypothesis #1, Staff Absences: These data were to have been secured from the Payroll Office of the selected school division. Usable data were unavailable due to the data tracking/storage methods in effect.

Hypothesis #2, Student Absences: These data were secured from the Educational Planning Center for the selected school division.

Hypothesis #3, Standardized Test Scores: These data were secured from the Educational Planning Center of the selected school division.

Hypothesis #4, Prophylactic Medications: These data were secured through the Coordinator of School Nurses of the selected school division via monthly reports.

Hypothesis #5, Rate of Staff Turnover: These data were secured though the Educational Planning Center of the selected school division.

Hypothesis #6, Behavior Referrals: These data were secured through a questionnaire issued to the schools involved in the study. The inconsistencies in the schools' recording and maintenance of the data for the years in question rendered them unusable.

Hypothesis #7, Suspensions and Recommendations for Expulsion: These data were secured from the Office for Alternative Education and Safe Schools for the selected school division.
Hypothesis #8, Changes in the Data Following the Public Announcement of the Sick Schools for hypotheses (1), 2, 3, and 5: These data were secured as outlined above.

Data Analysis

The eight groups of schools were paired according to their levels of instruction (elementary, middle, and high school), the percentage of eligible free and reduced lunch applicants, the student mobility indices, and ethnic balance. A factorial Analysis of Variance (ANOVA) for repeated measures was the statistic of choice.

Limitations of the study

The limitations of the study were as follows:

1. The sample was small and limited to one school division.

   While it would have been advantageous to examine this phenomenon in several school divisions, the issue of sick schools is politically volatile with far-reaching ramifications. The fact that the study accessed data from only one school division may limit its generalizability.

2. This study did not categorize the SBS schools as homogeneous in terms of the source of their diagnosis.

   In the selected school division, the schools identified as having SBS all had water to air source heat pumps. The heat pumps were from different manufacturers, varied in their locations (ground or roof level), and were merely assumed to have some relationship to the symptoms resulting in the diagnosis. An SBS diagnosis, by
definition, is one where "no specific cause can be identified" (Gardner, 1991, p. 30).

"Most investigations by the National Institute of Occupational Safety and Health (NIOSH) are not able to identify any specific contaminant. In 53% of the cases from 1971 to 1988, NIOSH could attribute the problem only to inadequate ventilation" (Laliberte, 1990, p. 65).

3. Some students take prophylactic medications at home without the knowledge of school personnel.

There was no known non-invasive way to control for this. It was assumed that the percentages of students medicated at home without the knowledge of the school were consistent across the population and did not statistically impact the study.

4. A recent change in the staff transfer procedures may have affected the percentage of transfers across the school division, causing an unrelated jump in the numbers of transfers since the SBS diagnoses became public. It was assumed that staff not negatively affected by SBS conditions had consistent rates of transfer regardless of whether or not they were in a "sick" school. Therefore any significant increases over this division-wide rate in the "sick" schools were attributed to the SBS factor.

5. Two hypotheses had to be abandoned because the data were not maintained in a manner that rendered them usable. The unavoidable loss of information on staff absences and behavior referrals necessarily narrowed the study from its proposed breadth.
Ethical Safeguards

This study was conducted in a manner that protected the identity of the selected school division and schools involved. A numbering system was used to code the data sources and report the results. Only the Division Superintendent has that code. This researcher guaranteed that any disclosures would be the sole prerogative of the Superintendent of the selected school division.

No individuals were identified and no data were collected on individual staff members or students. All data collected were historical in nature. No new data were generated or collected in the context of this study.

The proposal for this research was submitted to the Human Subjects Review Committee for the College of William and Mary. It was further approved by the superintendent of the selected school division and its School Board.
Chapter 2: Review of the Literature

Introduction

Sick building syndrome is a reality. Many schools have characteristics associated with sick buildings. In most communities, there is no alternate location for the teachers and students who are sensitive to the environmental conditions that cause their school building to be labeled sick. An overriding concern is whether or not schools that have sick building characteristics have a negative impact on the ability of the staff to teach and the children to learn.

The research question is, "Does poor indoor air quality, or Sick Building [School] Syndrome, negatively affect a school’s ability to carry out its mission?"

The following hypotheses were proposed in an effort to answer this question:

1. The percentage of staff absences in schools having a diagnosis of SBS will be significantly greater than the percentage of staff absences in schools which were not identified as being "sick,"

2. The average daily attendance (ADA) in schools having a diagnosis of SBS will be significantly lower than the ADA in schools which were not identified as being "sick,"

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3. Students' mean standardized test scores for reading and math in schools having a diagnosis of SBS will be significantly lower than students' mean standardized test scores for reading and math in schools which were not identified as being "sick."

4. There will be a significantly greater percentage of students taking prophylactic medications in schools diagnosed as having SBS than the percentage of students taking prophylactic medications in schools which were not identified as being "sick."

5. The percentage of staff turnover in schools having a diagnosis of SBS will be significantly greater than the percentage of staff turnover in schools which were not identified as being "sick."

6. There will be a significantly greater percentage of behavioral referrals for administrative intervention in schools having a diagnosis of SBS than the percentage of behavior referrals for administrative intervention in schools which were not identified as being "sick."

7. There will be a significantly higher percentage of suspensions and recommendations for expulsion in schools having a diagnosis of SBS than the percentage of suspensions and recommendations for expulsion in schools which were not identified as being "sick."

8. In schools having a diagnosis of SBS, staff attendance, student ADA and mean standardized test scores for math and reading will show a significant decrease while staff turnover will show a significant increase following the public announcement that the school has been identified as being "sick."
The investigation of the research question and the related hypotheses required a review of the literature that substantiated a link between the focus of each hypothesis and a school's ability to carry out its mission. The ensuing review investigates each criterion as a hallmark of an effective school in an effort to verify that the linkage is more than a sacred assumption.

Hypothesis 1:

The percentage of staff absences in schools having a diagnosis of SBS will be significantly greater than the percentage of staff absences in schools which were not identified as being "sick."

The selection of this focus assumed that a school's ability to carry out its mission is a function of staff attendance. The literature did little to substantiate this linkage beyond the status of sacred assumption. Study after study associated staff or teacher attendance as a related correlate to strong standardized test performance, but actual investigations of the relationship between the two were lacking.

A three year study was conducted by the Houston Independent School District in 1981. This study, called The Second Mile Plan, used incentive pay to improve student academic achievement, teacher attendance and reduce teacher turnover. For both years, teacher attendance and student achievement improved while staff turnover decreased (Miller, 1982, ab.). Like many studies, this one assumed a relationship among the three factors that was not investigated. Did the stability in the day-to-day and long term teaching force have an effect on the student achievement or did the incentive pay foster an increase in the teachers' commitment to better teaching?
South Carolina’s Education Improvement Act of 1984 included incentive grants for schools and districts for exceptional performance following a 1978-88 implementation of their plans. Exceptional performance focused on "improving student achievement, attendance and attitudes; teacher attendance; parent participation; and other factors promoting or maintaining high levels of achievement" (Thomas, 1984, ab.). Again, student achievement was found to be linked with teacher attendance.

A research report by Montero-Sieburth included a literature review which "indicated that... for learning to occur, stable teacher and student attendance patterns -- established through incentives, recognition and goal achievement -- must exist" (Montero-Sieburth, 1989, ab.).

Following the second year of implementation, a five year plan carried out in the Austin Independent School District showed improvement in achievement as measured by group and individually administered standardized tests. "Other indicators of success in these schools were: (1) improved attendance rates; (2) improved teacher attendance" (Cristner, 1990, ab.).

In Dallas, Texas, a "district-wide campus incentive pay plan rewarded all personnel in schools that ranked in the top quartile of schools exceeding achievement expectations and that met student and teacher attendance requirements. Program goals were achieved" (Wright, 1986, ab.). Again and again, the link was evident but not clearly demonstrated as causal.
In 1987 a six year study was completed by Moore for the purpose of identifying merit schools in Cincinnati, Ohio. Correlations were run in three groups: "academic achievement (reading, mathematics, and writing), attendance (student attendance, staff attendance), and attitudes ( interracial understanding, discipline, teacher attitude, parent attitude and student attitude)." The results showed that, with the exceptions of writing and staff attendance, the indicators were stable enough to warrant their use in identifying merit schools (Moore, 1987, ab.).

A 1991 study by Ehrenberg and others pointed out that "though higher student absenteeism correlated with poorer test performance, teacher absence was not largely associated with student test performance (Ehrenberg, 1991, ab.). Equally disheartening were the results of a 1981 study conducted in St. Louis, Missouri. Although previous achievement, student intelligence, and teacher experience could be used to predict future student achievement, the study concluded that "school level variables explain virtually none of the variation in the student achievement and that it is unlikely that such factors as...teacher and student attendance rates...will have much impact on student achievement" (Anderson, 1981, ab.).

Detroit's Peer Teachers as Mirrors and Monitors Project, reported on in 1985, did see a relationship between teacher attendance and student reading and mathematics achievement at the two schools implementing the project. "Teachers' attendance improved at School One and declined at School Two and the comparison site. In both reading and math achievement, School One outperformed School Two which outperformed the comparison school" (Sofer, 1985, ab.). With teacher attendance as
the reflected variable between School One and School Two, it appeared that the long-
held assumption concerning teacher attendance as a factor in a school's ability to
carry out its mission may have some legitimacy.

Hypothesis 2:

The average daily attendance (ADA) in schools having a diagnosis of SBS will be significantly lower than the ADA in schools not identified as being "sick."

Over the years, school boards across the nation have justified their attendance policies on the belief that student attendance and student achievement were linked. A student who is not in school is not being exposed to the school's curriculum and is, therefore, not expected to do well on the schools' choice of standardized achievement test(s). Incentive programs for improving student attendance were prolific and the focus of much research. Unfortunately, much of this research looked at whether or not the incentive program improved attendance, not whether the improved attendance improved learning. As with teacher attendance, many of the linkages reflect the time honored associations rather than empirical evidence. Statements such as, "Student attendance may be linked to effective school characteristics" (Lyons, 1988, ab.). "Academic achievement levels and student attendance increased..." (California University, 1989, ab.). "Evaluations indicate[d] better student attendance and higher scores on achievement tests" (Wiles, 1982, p. 53), and "District statistical data compiled over the last five years continue to be encouraging, showing a decline in
attrition while also showing increases in attendance and achievement among American Indian students" (Yagi, 1984, ab.) were indicative of our belief in the association.

The literature did, however, reflect some empirical evidence. Following its initial implementation of a new edition of the California Achievement Test, the North Carolina State Department of Public Instruction analyzed the results and concluded, among other things, that "There is a consistent relationship between student attendance and achievement" (North Carolina, 1986, ab.).

A 1983 study conducted by the Ganado, Arizona Unified School District looked at three variables and their effect on the standardized test performance of students in reservation schools. "Socio-economic status was the most consistent variable, showing a strong relation to academic achievement in all areas. Attendance had a significant effect on language and reading scores. Attendance was also a significant variable for students of low socio-economic status, as was the stability of enrollment" (Boloz, 1983, ab.). In 1991, Ehrenberg found that "higher student absenteeism correlated with poorer test performance" (Ehrenberg, 1991, ab.). And at the college level, Sade and Stroud found that "sophomores and juniors in medical school who habitually did not attend lectures, performed significantly lower and had lower grade point averages and board examination [scores]" (Sade, 1982, ab.).

More current studies included the work of Caldas in Louisiana public schools. His question was "How much relative influence do input and process factors have over school achievement?" (Caldas, 1993, p. 207). Input factors are those over which a school have little or no control. For this study, they were socioeconomic
status, demographics and school structure. Process factors are those over which control could be exercised. For this study they were class size, school structure and school attendance. Using multiple regression techniques, Caldas examined whether the three process factors accounted for any additional explained variance in school achievement after removing the effects of the input variables. Among his findings were that, although all three process factors had significant effects on elementary school achievement, they collectively accounted for only 3% of the variance in achievement beyond that explained by the input factors. By contrast, student attendance was the only statistically significant process factor of secondary school achievement, yet it alone accounted for 5.5% of the variance of secondary school achievement beyond that explained by all input and process factors (Caldas, 1993, p. 213).

Although a specific causal relationship was not identified, McPartland and Nettles linked student attendance and report card grades in their study which emphasized the use of community adults as advocates. Project RAISE, a multifaceted approach featuring outside adults as school-based advocates and one-on-one mentors for at-risk students at seven middle schools, was evaluated on selected student outcomes after two years of operation. The basic RAISE strategy was to create, on a large scale, the kind of sustained caring connections which can make a dramatic difference in the lives of very high at-risk children. Statistically significant positive effects were noted on two outcomes; absence rates and report card grades. McPartland and Nettles shared the assumption that good school attendance can often
be a building block to other school behaviors required for school success. Student learning as measured by standardized test scores can also be expected to suffer as a result of poor attendance, because absent students will miss instruction and engage in less drill and practice in the basic skills covered by tests (McPartland & Nettles, 1991, pp. 568, 571, 577, 582).

The popular Accelerated Schools movement out of Stanford University listed as its "early outcomes improved student attendance and achievement" (Hoffenberg, 1990, ab.).

Although the empirical evidence positively linking student attendance to achievement is stronger than the evidence linking teacher attendance to achievement, it remains apparent that the factor carries more weight as a long held assumption than a demonstrated truth.

Hypothesis 3:

Students’ mean standardized test scores for reading and math in schools having a diagnosis of SBS will be significantly lower than students' mean standardized test scores for reading and math in schools which were not identified as being "sick."

Again, logic prevails in the absence of empirical studies on the test performance of students who were not at their physical optimum. With Sick Building Syndrome, the symptoms are physical. They are present when the individual is in the "sick" environment and disappear when the environment is left. The most common symptoms include headaches, dizziness, eye irritation, fatigue, and respiratory
discomfort. A sub-standard performance is the expected result of anyone suffering in this manner. Rapp reported that, "Children can suffer from allergies that can markedly affect their behavior and school performance" (Rapp, 1990, p.27). Glines felt that "many students who do not reach their full potential may [have been] victims of Environmental Illness Syndrome (EIS)" (Glines, 1988, ab.)

"Clinical ecologists have demonstrated that such physical, mental, or emotional problems as hyperactivity, migraine headaches, depression, fatigue, irritability, drowsiness, internal organ malfunction, tension, arthritis, asthma, alcoholism, skin rashes, gastrointestinal ailments such as constipation and diarrhea and dizziness, nausea, muscle pain, autism, schizophrenia, temporary hoarseness and speech slurring, and some mouth, ear, eye, and nose problems can be triggered by allergic reactions" (Glines, 1983, p.60).

Consistent with the understanding that individuals who suffer from SBS are simply more sensitive or allergic to the negative impacts of the environmental stimuli present to all in that environment, and in conjunction with Rapp's and Glines's evidence that allergies can negatively affect a student's ability to benefit from his education program, it stands to reason that those who are experiencing SBS symptoms are not in an optimal, or even satisfactory, physical state for learning or quality test performance.

The instruments used to measure the independent variables for this hypothesis were the Iowa Test of Basic Skills (ITBS) and the Tests of Achievement and
Proficiency (TAPS). Both are published by Riverside Publishing Company and both were part of the Virginia State Assessment Program at the time of this study.

The ITBS, TAPS, and Cognitive Abilities Test were standardized jointly. Approximately 15,000 pupils per grade level were used in establishing fall norms in 1984. Spring norms (used in this study) were established on a 33% representative subsample in 1985. Criteria used in selecting and weighting were region, size of school district, family income, and education. Reliabilities vary from test to test and grade to grade. Internal consistency reliability coefficients for the five main area scores (two of which were selected for this study) range from .84 to .96; composite reliability is .98 for all grades (Riverside, 1986, pp. 3-4).

Hypothesis 4:

There will be a significantly greater percentage of students taking prophylactic medications in schools identified as having SBS than the percentage of students taking prophylactic medications in schools which were not identified as being "sick."

Reports show that most common prophylactic medications taken the schools under study are the stimulants taken in an effort to improve attending behaviors in attention deficit and attention deficit/hyperactive disordered (ADD/ADHD) students and the inhalers used by asthmatics and selected others with upper respiratory difficulties.

Rapp substantiated that a diagnosis of ADD/ADHD is often the result of an environmental allergy that causes the student to have a central nervous system
reaction. It is therefore logical that schools identified as being "sick" would have more referrals to physicians for attending difficulties and/or hyperactivity. Unless the physician is allergy-wise and orders allergy testing, s/he is likely to see the typical ADD/ADHD profile and prescribe the expected stimulant. In some allergy-related cases, stimulants affect the resulting behaviors in a positive way; in most cases, they do not (Rapp, 1991, p. 351).

In 1989, Marshall of the University of Minnesota wrote of the relationship between ADHD and allergies from a biochemical perspective. He hypothesized that allergic reactions result in an autonomic and central nervous system imbalance similar to the changes seen in a child with ADHD (Block, 1995, p.128).

Since the "Sick School Syndrome" cases being studied herein were limited to those with air quality problems related to HVAC systems, the number of students suffering from upper respiratory problems and needing inhalers was likely to be greater than it was in schools not identified as being "sick."

Both categories of prophylactic medications were included in this hypothesis. Again ones logic and ability to relate personally are called on. If one doesn’t feel in control or doesn’t feel well, then one is distracted from doing his best and achievement is likely to be affected. However, both categories of medication are stimulants and could cause the student to feel better and more focussed on the task at hand. Perhaps it was the student without the need for and benefit of a stimulant who was negatively affected by his omission from the category.
In 1993, Carson and Bunner reviewed a number of studies on the effects of psycho-stimulant medication on students with ADHD. "Focusing on classroom academic performance and standardized test achievement, the studies of acute effects on daily classroom performance consistently reveal substantial beneficial effects of medication, whereas studies of achievement over periods of months and years fail to yield evidence of beneficial medication effects" (Carlson, 1993, p.184). Despite their findings, the authors have stated that if the short term effects are positive, it would follow that the long term effects, too should be beneficial. "While it is easy to criticize the long term studies for methodological problems, it must be noted that a study designed to optimally test the long term impact of stimulants would be extremely difficult to implement due to a variety of practical and ethical issues (Carlson, 1993, p. 194).

"Using a 'review of reviews' methodology, a literature synthesis conducted by James Swanson and others, on stimulant use with children with ADD compared three reviews from each of three review types (traditional, meta-analytic, and general audience). A consensus was found to exist about...the acknowledged limitations of stimulant medication" (Swanson, 1993, p. 160).

Forness conducted a study using seventy-one ADHD boys between the ages of seven and eleven, all of whom were on methylphenidate (Ritalin) using six different measures of cognitive, academic, and social functioning. His results suggested "classifying a child as a responder to methylphenidate depends on the choice of outcome measure" (Forness, 1992, p. 50). Using a sub group of only forty-two boys
with ADHD and conduct disorders, Forness looked at the effects of methylphenidate on reading performance. "Significant reading improvement was exhibited in only the subgroup of these students" (Forness, 1992, p. 50).

Burchfield and Easterday looked at one hundred thirty-seven students in grades six through eight who had diagnosed [upper respiratory] inhalant allergies. They found "no significant differences between the mean scores of the sixth and seventh grade students with and without inhalant allergies on a mathematics concepts subtest, but found that eighth grade students with inhalant allergies performed better than eighth grade students without allergies" (Burchfield, 1991, ab.).

Hypothesis 5:

The percentage of staff turnover in schools having a diagnosis of SBS will be significantly greater than the percentage of staff turnover in schools which were not identified as being "sick."

The Superintendent and School Board for the school division selected for this study guaranteed a transfer to a school not identified as being "sick" for any student or staff member suffering from Sick Building Syndrome. Such individuals were classified as involuntary transfers and were assured a welcome at an alternate site. To date, very few students, but a number of staff members have elected to transfer. It stands to reason that a significant staff turnover can negatively affect a school's ability to carry out its mission. The common vision is jeopardized and the new staff members must be assimilated into the culture of their new worksites. In today's arena
of shared decision making, trust must be re-established and new roles must be learned.

Miller found that "student test scores improved as teacher turnover decreased" in New York City (Miller, 1982, ab.). A report on small rural school districts in Washington found that where teacher turnover was below average, graduating seniors performed better than average on the Standardized Achievement Test (SAT), despite the fact that slightly fewer went to college and slightly more went to technical school (Barker, 1983, ab.).

Although the references were limited, they did reflect both urban and rural settings. The literature tends to support the assumption that a stable staff support a school’s ability to carry out its mission.

Hypothesis 6:

There will be a significantly greater percentage of behavior referrals for administrative intervention in schools having a diagnosis of SBS than the percentage of behavior referrals for administrative intervention in schools which were not identified as being "sick."

It is a tenet of the field of education that disruptive behavior is disruptive to the educational process. It is not only the disruptive student who loses as he is sanctioned and quite possibly removed from the classroom environment; it is the balance of the class that loses valuable instructional time as they are distracted by the disruption and await the teacher’s return to the focus of the lesson. The momentum
and teachable moment are lost, and depending on the nature of the disruption, so is the lesson.

This perception is reinforced in the Superintendent's introductory letter to the parents, teachers and students through the selected school division's Code of Student Conduct. It reads in part, "Safe, secure schools for students and staff are essential to teaching and learning. Parents must know that their children will be safe and secure at school and that their children will receive first class instruction in a disruption-free, non-threatening environment" (VBCPS, 1994, p. 1).

Hypersensitivities to environmental irritants, also known as allergies, are documented causes of behavior problems. In her many publications on the subject, Rapp alerts us to "recognize allergies as causes of learning and behavior problems" (Rapp, 1991, p. 7). In "Allergies: The Hidden Hazard," she cautions that "Children can suffer from allergies that can markedly affect their behavior and school performance" (Rapp, 1990, p. 27). In separate publications, Vass and Crook write about the role of allergies in childhood behavior problems (Vass, 1984, ab.) (Crook, 1984, ab.). These authors shed new light on the conference where the teacher describes the disruptive behavior of her student to the incredulous parent who has never seen her child as a behavior problem.

"The influence of the nervous system on the immune system is one that has been recognized for centuries. Today there is evidence that the opposite effect, that of the immune system on the nervous system, also occurs. Our immune cells produce chemicals which communicate with our nervous system. A challenge to our immune
system, such as an allegic reaction in which histimine is released, can result in the release of neurochemicals which influence the way we feel and act" (Block, 1995, p. 127,8).

Hypotheses 7:

There will be significantly higher percentage of suspensions and recommendations for expulsion in schools having a diagnosis of SBS than the percentage of suspensions and recommendations for expulsions in schools which were not identified as being "sick."

This hypothesis simply carried the previous hypothesis one step further. If SBS can foster behavior problems, can it exacerbate the negative behaviors of those who would be behavior challenges were they not attending school in a "sick" building? Any disruption deserving such a consequence would be likely to further inhibit a school in carrying out its mission.

The selected school division's Code of Student Conduct lists 58 behaviors warranting a referral for disciplinary action. The list carries a statement indicating that it is not exhaustive in terms of behaviors that may result in disciplinary action. Six of the behaviors require an immediate referral to the principal or an assistant principal. They are:

1. Fighting;
2. Abusive language directed toward a teacher or another student;
3. Student actions that disrupt the class to the extent that the teacher’s authority is being challenged and the teacher is losing control of the class;

4. Student actions which indicate the use of drugs, alcoholic beverages, or other behavior altering substances;

5. Student actions that present a danger to the safety and well-being of anyone in the school;

6. Other criminal acts in violation of local, state or federal laws [VBCPS, 1994, p.16].

The selected school division’s Code of Student Conduct is specific with regard to offenses warranting a recommendation for expulsion. They are:

1. Arson or attempted arson;

2. Assault and/or battery of an employee or student;

3. Possession, use, or sale of a firearm or dangerous weapon;

4. Manufacturing, growing, distribution, and/or sale of drugs and/or drug paraphernalia;

5. Extortion, attempted extortion, robbery and/or larceny;

6. Immoral conduct;

7. Hazing;

8. Unlawful assembly and/or riot;

9. Possession, use, distribution, sale, lighting and/or discharge of explosive devices;
10. Students found guilty or not innocent of a crime which resulted in or could have resulted in injuries to others, regardless of where the crime occurred (VBCPS, 1994, p.17).

Hypothesis 8:

In schools having a diagnosis of SBS, staff attendance, student ADA and mean standardized test scores for reading and math will show a decrease following the public announcement that the school has been identified as being "sick."

In searching for studies that reflect the impact of attention to a given factor and its impact on outcome measures, the famous Hawthorne studies of 1927 - 1932 surface again and again. These analyses constituted the first major study of the effect of human behavior on worker productivity. They were conducted at Western Electric's Hawthorne Plant in Chicago, Illinois as a joint effort between Western Electric and Harvard Business School. As a major landmark in the investigation of human behavior, their importance was discovered almost accidentally. Using a classic experimental design, the researchers attempted to measure the impact of various working conditions on job productivity. The most famous aspect of the studies was the impact of illumination (lighting) on the workers' productivity. When the productivity of both the experimental and control groups increased, the researchers were shocked. They were further amazed when a decrease in lighting for the experimental group resulted in even greater productivity. Productivity for the control group continued to increase as well.
"Further study led to the conclusion that the experiments had failed to control one vital element...the worker" (Herbert, 1976, p. 16). All of the workers had felt special because they had been singled out for an experiment. Feeling that they were important, they lived up to what they felt to be perceived expectations. A major feature of the study was the special status which the [workers] enjoyed" (Mouly, 1970, p. 451). "As was shown in the Hawthorne Studies, even careful studies of real people under real conditions cannot control and prevent unwanted and unscientific elements from intruding on the experiment" (Herbert, 1976, p. 44). "Individual behavior is not the result of a simple stimulus-response relationship. Attitudes are formed in the process of evaluation and comparison with desires or expectations" (Herbert, 1976, p. 133). A 1989 meta-analysis conducted by Adair and others focused on "86 studies and 256 treatment/Hawthorne/no treatment control group effect size comparisons. [The analysis indicated that] artifact controls have limited utility when dealing with the Hawthorne Effect" (Adair, 1989, ab.) "Most pertinent...is the vitiating influence which the Hawthorne Effect often has on the validity of experimental findings" (Mouly, 1976, p. 452).

It was expected that the public announcement that a school building is "sick" and the resulting attention would have an impact on selected outcome measures of this study; namely staff attendance, student ADA and standardized test scores in reading and math. This researcher felt that each would drop as a reflection of public's expectations that illness is more likely in a sick building and that test scores will
decrease in accordance with the expectation that the students’ ability to benefit from their educational programs is diminished.

Conclusions:

Eight hypotheses were selected for study. Seven of the hypotheses were selected as factors related to a school’s ability to carry out its mission. The eighth was selected to look at the effects of the public announcement of a school as having SBS and its effect on three of the hypotheses. In each case differences were expected to be revealed between the outcome measure for schools identified as having Sick building Syndrome and those not identified as being "sick." This review of literature was constructed in a effort to substantiate the expected outcomes.
Chapter 3: Procedures

Introduction

This study examined the relationship between factors assumed or determined to have an impact on a school's ability to carry out its mission as they related to a diagnosis of Sick Building Syndrome (SBS). The factors targeted for study were staff absences, student absences, students' mean standardized test scores, the need for students to take prophylactic medications, the rate of staff turnover, behavior referrals, short and long term suspensions, recommendations for expulsion, and the impact of the public identification of the "sick" schools on staff absences, student attendance, students' standardized test scores in reading and math and staff turnover.

Hypotheses

Eight hypotheses were proposed for this study. They were as follows:

1. The percentage of staff absences in schools having a diagnosis of SBS will be significantly greater than the percentage of staff absences in schools which were not identified as being "sick."

2. The average daily attendance (ADA) in schools having a diagnosis of SBS will be significantly lower than the ADA in schools which were not identified as being "sick."
3. Students' mean standardized test scores for math and reading in schools having a diagnosis of SBS will be significantly lower than students' mean standardized test scores for reading and math in schools which were not identified as being "sick."

4. There will be a significantly greater percentage of students taking prophylactic medications in schools diagnosed as having SBS than the percentage of students taking prophylactic medications in schools which were not identified as being "sick."

5. The percentage of staff turnover in schools having a diagnosis of SBS will be significantly greater than the percentage of staff turnover in schools which were not identified as being "sick."

6. There will be a significantly greater percentage of behavior referrals for administrative intervention in schools having a diagnosis of SBS than the percentage of behavior referrals in schools which were not identified as being "sick."

7. There will be a significantly higher percentage of suspensions and recommendations for expulsion in schools having a diagnosis of SBS than the percentage of suspensions and recommendations for expulsions in schools which were not identified as being "sick."

8. In schools having a diagnosis of SBS, staff attendance, student ADA and mean standardized test scores for math and reading will show a significant decrease while staff turnover will show a significant increase following the public announcement that the school has been identified as being "sick."
In order to test these hypotheses, eight public schools identified as having Sick Building Syndrome (SBS) from a selected Virginia school division were matched with an equivalent number of schools from the same school division which were not diagnosed, and did not have the potential of being diagnosed, as having SBS. The schools identified as having SBS were certified by Dr. James Woods of Virginia Polytechnic Institute who was serving as a consultant to the school division. A list of the schools was published in the local newspaper in November of 1992. All identified schools had their SBS diagnosis attributed to a Heating, Ventilating, and Air Conditioning (HVAC) source. All were fairly new in construction and all had water to air source heat pumps. The architects and builders of the schools varied as did the manufacturers for the heat pumps.

The matching schools were selected by this researcher from the remaining non-identified public schools in the school division. The criteria for matching included the percentage of free and reduced lunch eligibilities, the school’s mobility index, the instructional level (K-5 = elementary, 6-8 = middle, 9-12 = high school), and ethnic balance (Caucasian, African American, Asian/Pacific Islander, and Other) for the 1993-94 school year. Because of the potential for diagnosis, no school that had undergone a major renovation since 1975 was considered for matching. It was deemed that such a renovation would have subjected the facility to the same energy efficiency modifications that fostered the SBS in the identified schools.
Permission for the study obtained from the Superintendent and the School Board of the selected division.

Instrumentation

This study looked at eight matched pairs of schools for nine variables across four years.

A factorial Analysis of Variance (ANOVA) model (2x4) for repeated measures was the statistic of choice. The first factor represented the "sick"/not "sick" variable. The second factor, the repeated measures, represented the year.

Experimental Design

This study implemented a causal comparative design using Analysis of Variance in an effort to examine and compare the schools identified as having SBS with an equivalent number of matched schools which were neither identified as being "sick" nor had a known potential for the SBS diagnosis. All data used in this study were archival in nature.

Data Collection

The selected school division's Office of Human Resources was contacted for data for hypothesis 1 concerning staff absences. The data base used to document staff absences had been established to follow the employee rather than the employment site. Once a school year had ended, and staff had been transferred for the subsequent year, the data could not be re-configured to provide this researcher with staff absence
patterns by school for the years under study. With the hope that the individual schools had maintained their end-of-the-year printouts concerning staff absences, this researcher contacted the principals of the schools being studied. The data were available on such an inconsistent basis that the hypothesis was abandoned.

The selected school division’s Educational Planning Center provided the data on hypotheses 2, 3, and 5 concerning student absences, standardized test scores and the rate of staff turnover. These data were compiled annually as part of a publication entitled: School Profiles.

The selected school division’s Office for Alternative Education and Safe Schools provided the data for hypothesis 7 concerning suspensions and recommendations for expulsion. These data included short term suspensions (less than 10 days), long term suspensions (greater than 10 days) and recommendations to the School Board for expulsion from school for one or more years.

The data for hypothesis 4 concerning prophylactic medications were also secured through the Office of Alternative Education and Safe Schools. The Coordinator for School Nurses made the end-of-the-year reports available to this researcher who calculated the totals and compiled the data needed.

Hypothesis 6 concerning behavior referrals to each school’s administrative office were secured through a questionnaire to each of the principals of the sixteen schools in the study. The principals were asked to provide the number of referrals made via form IS-8-30-89, a referral form used division-wide for infractions serious enough to warrant administrative intervention. Although each principal responded to
the request for data, it was determined to be unusable for several reasons. Few of the
elementary schools contacted had transferred the referral information to a computer
data base. Hand counting several hundred forms for each school year was bound to
result in inaccuracies. Furthermore, a student's discipline record followed him as he
changed schools both within and outside the school division. The mobility rate in
some of the schools evaluated exceeded 35% each year. That 35% most likely
contained students who had behavior referrals which could not be part of the count in
schools which did not have a computer data base for this information. Due to the
unreliability of the data secured, this hypothesis was abandoned.

Data Reliability

The data for hypothesis 2, concerning student attendance, are reliable data.
These data are for Average Daily Attendance (ADA). They are directly linked to the
state funding formula and are accepted as reliable.

The data for hypothesis 3, concerning mean standardized test scores in
reading and math were collected as part of the Virginia Assessment Program. The
achievement tests used were the Iowa Tests of Basic Skills for elementary students
and middle school students and the Tests of Achievement and Proficiency for high
school students. Both Tests are from the Riverside Publishing Company and meet the
state's standards for validity and reliability.

It is understood that the variance between schools on mean test scores may
have been affected by the inclusion of scores from identified special education
students. The scores were not disaggregated for this factor because, for the years evaluated, the schools did not have the option of identifying a field for this purpose. Special education programs are housed in all schools within the selected school division with students in the less severe categories, those most likely to be included in the state testing program, being included in nearly every school population. Therefore, it was felt by this researcher that any variance related to identified special education students would not adversely affect the purposes or outcome of this study.

The data for hypothesis 4, concerning prophylactic medications did not discriminate among medications. Regularly submitted reports reveal that most medications taken in the selected school division are for ADD/ADHD, asthma, and seizure activity. All three of these conditions can be exacerbated by a sensitivity to SBS. A sensitivity to SBS has even been found to bring on the reaction which results in one of the three diagnoses (Rapp, 1995, p.?). It was felt that any need for prophylactic medications not related to the SBS condition would be consistent across the population and therefore, would not adversely affect the study. Additionally, there were students who did not take their medications at school. These students were not reflected in the data. Again, it was felt that such a subgroup would be consistent across the population and would not adversely affect the study.

The data for hypothesis 5, concerning staff turnover, were those generated by the VBCPS Office of Human Resources for their annual report to the VBCPS Education Planning Center. There was no reason to doubt their accuracy.
The data for hypothesis 7 concerning suspensions and recommendations for expulsions were compiled by the school division's Office for Alternative Education and Safe Schools from information sent by the individual schools. School Board Regulations required that every short term suspension be reported to this office via a copy of the suspension letter. It was felt that these data were consistent across the schools studied because all of the schools in the school division are governed by the same Code of Student Conduct which outlines offenses requiring a suspension. Some of the schools had In-School Suspension programs which reduced the number of Out-Of-School Suspensions, but both categories were classified as suspensions and were reported to the Office for Alternative Education and Safe Schools in the same manner. Additionally, some schools had Saturday Detention Programs. It is assumed that such programs addressed students committing borderline offenses which might have resulted in a short term suspension in a school without the Saturday Detention option; however no control was exercised for this possible variance by this researcher.

Long term suspensions necessitated a request for "permission" from the Office for Alternative Education and Safe Schools as they carried the additional responsibility of determining if a causal hearing was required. Recommendations for expulsion must be addressed by the School Board and carried an even greater reporting burden. There was no reason to doubt the accuracy of these data.
Chapter 4: Analysis of Results

Introduction

This study looked at the relationship between factors assumed or determined to have an impact on a school’s ability to carry out its mission as they related to a diagnosis of Sick Building Syndrome (SBS). The factors analyzed in the study were student attendance, students’ mean standardized test scores, the need for students to take prophylactic medications, the rate of staff turnover, short and long term suspensions and recommendations for expulsion, and the impact of the public identification of the "sick" schools on staff absences, student attendance, students’ standardized test scores, and staff turnover.

Sample

Eight public schools identified as having Sick building Syndrome (SBS) from a selected Virginia school division were matched with an equivalent number of schools from the same school division which were not diagnosed and did not have the potential of being diagnosed as having SBS. The schools identified as having SBS were recognized by Dr. James Woods of Virginia Polytechnic Institute who was serving as a consultant to the school division. A list of the schools was published in the local newspaper in November of 1992. All identified schools attributed their SBS
diagnosis to a Heating, Ventilating, Air Conditioning (HVAC) source. All were fairly new construction and all had water-to-air source heat pumps. The architects and builders varied as did the manufacturers for the heat pumps.

The matching schools were selected by this researcher from the remaining non-identified public schools in the selected school division. The criteria for matching included the percentage of free and reduced lunch eligibilities, the school's mobility index, ethnic balance (Caucasian, African American, Asian Pacific Islander and Other), and the instructional level (K-5 = Elementary, 6-8 = Middle, 9-12 = High schools) for the 1993-94 school year. Because of the potential for diagnosis, no school that had undergone a major renovation since 1975 was considered for matching. It was deemed that such a renovation would have subjected the facility to the same energy efficiency modifications that fostered the SBS in the identified schools.
Table 1 shows the matched pairs and the criteria used for their matching where S refers to the "sick" schools and NS refers to those schools not identified as being "sick."

<table>
<thead>
<tr>
<th>Pairs</th>
<th>Year of Construction</th>
<th>%age of Free/Reduced Lunches</th>
<th>Mobility Index</th>
<th>Ethnic Balance</th>
<th>Inst. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S</td>
<td>1991</td>
<td>15%</td>
<td>26%</td>
<td>83%</td>
<td>10%</td>
</tr>
<tr>
<td>1NS</td>
<td>1959</td>
<td>27%</td>
<td>24%</td>
<td>73%</td>
<td>19%</td>
</tr>
<tr>
<td>2S</td>
<td>1986</td>
<td>71%</td>
<td>43%</td>
<td>60%</td>
<td>32%</td>
</tr>
<tr>
<td>2NS</td>
<td>1952</td>
<td>89.5%</td>
<td>48%</td>
<td>34%</td>
<td>63%</td>
</tr>
<tr>
<td>3S</td>
<td>1989</td>
<td>5.1%</td>
<td>16%</td>
<td>90%</td>
<td>7%</td>
</tr>
<tr>
<td>3NS</td>
<td>1966</td>
<td>29%</td>
<td>30%</td>
<td>75%</td>
<td>20%</td>
</tr>
<tr>
<td>4S</td>
<td>1990</td>
<td>18.4%</td>
<td>27%</td>
<td>79%</td>
<td>15%</td>
</tr>
<tr>
<td>4NS</td>
<td>1962</td>
<td>24.2%</td>
<td>23%</td>
<td>81%</td>
<td>15%</td>
</tr>
<tr>
<td>5S</td>
<td>1990</td>
<td>23.5%</td>
<td>22%</td>
<td>60%</td>
<td>27%</td>
</tr>
<tr>
<td>5NS</td>
<td>1966</td>
<td>30.8%</td>
<td>39%</td>
<td>76%</td>
<td>19%</td>
</tr>
<tr>
<td>6S</td>
<td>1981</td>
<td>33.2%</td>
<td>32%</td>
<td>61%</td>
<td>28%</td>
</tr>
<tr>
<td>6NS</td>
<td>1969</td>
<td>34.5%</td>
<td>31%</td>
<td>77%</td>
<td>19%</td>
</tr>
<tr>
<td>7S</td>
<td>1988</td>
<td>15.1%</td>
<td>17%</td>
<td>61%</td>
<td>22%</td>
</tr>
<tr>
<td>7NS</td>
<td>1969</td>
<td>39.6%</td>
<td>19%</td>
<td>60%</td>
<td>31%</td>
</tr>
<tr>
<td>8S</td>
<td>1989</td>
<td>10.1%</td>
<td>23%</td>
<td>59%</td>
<td>23%</td>
</tr>
<tr>
<td>8NS</td>
<td>1962</td>
<td>5.7%</td>
<td>24%</td>
<td>82%</td>
<td>11%</td>
</tr>
</tbody>
</table>

C = Caucasian       AA = African American       API = Asian/Pacific Islander
O = Other           M = Middle               H = High School
Data Analysis

The following figures represent the raw and summary data as collected for Hypotheses 2, 3, 4, 5 and 7 of this study. For all hypotheses, the data from 1989-90 were rejected due to inconsistencies in its availability. In some cases a "sick" school was not open during this school year. In others, the mechanism for reporting the data to a central office was not yet in place. It was felt that these data were deemed to be unreliable.

**Hypothesis 2:** The Average Daily Attendance (ADA) in schools having a diagnosis of SBS will be significantly lower than the ADA in schools which were not identified as being "sick."

Table 2 shows the raw data for this hypothesis. Table 3 shows the summary data and p values for this hypothesis. Analysis of variance indicates no statistical evidence to suggest a causal relationship between a school having a diagnosis of Sick Building Syndrome and its Average Daily Attendance.
Table 2

<table>
<thead>
<tr>
<th>Pairs</th>
<th>90-91</th>
<th>91-92</th>
<th>92-93</th>
<th>93-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S</td>
<td>NA</td>
<td>95.4%</td>
<td>96.1%</td>
<td>96.2%</td>
</tr>
<tr>
<td>1NS</td>
<td>96.3%</td>
<td>96.7%</td>
<td>96.4%</td>
<td>96.4%</td>
</tr>
<tr>
<td>2S</td>
<td>94.4%</td>
<td>95%</td>
<td>94.6%</td>
<td>94.6%</td>
</tr>
<tr>
<td>2NS</td>
<td>94.9%</td>
<td>93.8%</td>
<td>94.7%</td>
<td>94.0%</td>
</tr>
<tr>
<td>3S</td>
<td>96.1%</td>
<td>96.8%</td>
<td>95.6%</td>
<td>96.6%</td>
</tr>
<tr>
<td>3NS</td>
<td>95.9%</td>
<td>95.9%</td>
<td>95.4%</td>
<td>96.2%</td>
</tr>
<tr>
<td>4S</td>
<td>95.6%</td>
<td>95.8%</td>
<td>95.6%</td>
<td>96.0%</td>
</tr>
<tr>
<td>4NS</td>
<td>95.4%</td>
<td>95.8%</td>
<td>95.9%</td>
<td>95.8%</td>
</tr>
<tr>
<td>5S</td>
<td>96.3%</td>
<td>95.6%</td>
<td>96.1%</td>
<td>96.2%</td>
</tr>
<tr>
<td>5NS</td>
<td>95.4%</td>
<td>96.4%</td>
<td>95.6%</td>
<td>95.5%</td>
</tr>
<tr>
<td>6S</td>
<td>96.1%</td>
<td>96.2%</td>
<td>95.8%</td>
<td>95.6%</td>
</tr>
<tr>
<td>6NS</td>
<td>95.8%</td>
<td>96.4%</td>
<td>95.6%</td>
<td>95.7%</td>
</tr>
<tr>
<td>7S</td>
<td>94.9%</td>
<td>96.9%</td>
<td>95.0%</td>
<td>95.5%</td>
</tr>
<tr>
<td>7NS</td>
<td>92.9%</td>
<td>95.9%</td>
<td>94.0%</td>
<td>93.6%</td>
</tr>
<tr>
<td>8S</td>
<td>93.2%</td>
<td>93.9%</td>
<td>92.3%</td>
<td>92.6%</td>
</tr>
<tr>
<td>8NS</td>
<td>92.9%</td>
<td>94.9%</td>
<td>92.3%</td>
<td>92.4%</td>
</tr>
</tbody>
</table>
Table 3

Summary Data for the Average Daily Attendance for the Schools Studied for Each Year of the Study

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sick</td>
<td>95.2</td>
<td>95.7</td>
<td>95.0</td>
<td>95.3</td>
</tr>
<tr>
<td>Not Sick</td>
<td>94.9</td>
<td>95.7</td>
<td>95.0</td>
<td>95.0</td>
</tr>
</tbody>
</table>

p value for S/NS (main effect) = .78
p value for S/NS by year (interaction effect) = .764
Mean Squares = .42 F = .08

Hypothesis 3: Students' mean standardized test scores for reading and math in schools having a diagnosis of SBS will be significantly lower than students’ mean standardized test scores for reading and math in schools which were not identified as being "sick."

Table 4 shows the raw data for this hypothesis. Tables 5 and 6 show the summary data and p values resulting from the Analysis of Variance for this hypothesis. Respective main effects p values of .93 and .64 and interaction effects p values of .5 and .42 indicate there is no statistical evidence to suggest a causal relationship between a school having a diagnosis of SBS and its students’ mean standardized test scores for reading and math.
Table 4

Raw Data on Mean Standardized Test Scores as Percentile Rankings for the ITBS and TAPS for the Selected Schools During the Years Studied

<table>
<thead>
<tr>
<th>Pairs</th>
<th>90-91</th>
<th>91-92</th>
<th>92-93</th>
<th>93-94</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>M</td>
<td>R</td>
<td>M</td>
</tr>
<tr>
<td>1S</td>
<td>73</td>
<td>68</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>1NS</td>
<td>55</td>
<td>59</td>
<td>55</td>
<td>63</td>
</tr>
<tr>
<td>2S</td>
<td>46</td>
<td>59</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td>2NS</td>
<td>55</td>
<td>57</td>
<td>49</td>
<td>46</td>
</tr>
<tr>
<td>3S</td>
<td>63</td>
<td>62</td>
<td>66</td>
<td>68</td>
</tr>
<tr>
<td>3NS</td>
<td>59</td>
<td>62</td>
<td>66</td>
<td>65</td>
</tr>
<tr>
<td>4S</td>
<td>57</td>
<td>60</td>
<td>53</td>
<td>60</td>
</tr>
<tr>
<td>4NS</td>
<td>70</td>
<td>75</td>
<td>75</td>
<td>83</td>
</tr>
<tr>
<td>5S</td>
<td>62</td>
<td>60</td>
<td>66</td>
<td>64</td>
</tr>
<tr>
<td>5NS</td>
<td>68</td>
<td>70</td>
<td>67</td>
<td>74</td>
</tr>
<tr>
<td>6S</td>
<td>53</td>
<td>66</td>
<td>62</td>
<td>74</td>
</tr>
<tr>
<td>6NS</td>
<td>58</td>
<td>67</td>
<td>55</td>
<td>68</td>
</tr>
<tr>
<td>7S</td>
<td>59</td>
<td>63</td>
<td>58</td>
<td>60</td>
</tr>
<tr>
<td>7NS</td>
<td>46</td>
<td>51</td>
<td>56</td>
<td>60</td>
</tr>
<tr>
<td>8S</td>
<td>60</td>
<td>59</td>
<td>58</td>
<td>60</td>
</tr>
<tr>
<td>8NS</td>
<td>59</td>
<td>57</td>
<td>59</td>
<td>63</td>
</tr>
</tbody>
</table>

For pairs 1-7, which include elementary and middle schools, the test administered was Iowa Test of Basic Skills. The scores reflected are for Reading (R) and Mathematics (M). For the Eighth pair, the test administered was the Tests of Achievement and Proficiency (TAPS). The scores reflected are for Reading Comprehension (R), and Mathematics (M).
Table 5

Summary Data on Mean Standardized Math Test Scores as Percentile Rankings for the ITBS and TAPS for the Selected Schools for the Years Studied

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sick</td>
<td>61.3</td>
<td>64.3</td>
<td>63.7</td>
<td>64.0</td>
</tr>
<tr>
<td>Not Sick</td>
<td>63.4</td>
<td>66.1</td>
<td>63.6</td>
<td>61.4</td>
</tr>
</tbody>
</table>

p value for S/NS (main effect) = .93
p value for S/NS by year (interaction effect) = .5
Mean Squares = 17.77 F = .8

Table 6

Summary Data on Mean Standardized Reading Comprehension (RC) Test Scores as Percentile rankings for the ITBS and TAPS for the Selected Schools for the Years Studied

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sick</td>
<td>57.1</td>
<td>59.0</td>
<td>60.1</td>
<td>61.3</td>
</tr>
<tr>
<td>Not Sick</td>
<td>61.0</td>
<td>62.1</td>
<td>60.5</td>
<td>61.4</td>
</tr>
</tbody>
</table>

p value for S/NS (main effect) = .64
p value for S/NS by year (interaction effect) = .42
Mean Squares = 13.67 F = .96

Hypothesis 4: There will be a significantly greater percentage of students who take prophylactic medications in schools having a diagnosis of SBS than the percentage of
students taking prophylactic medications in schools which were not identified as being "sick."

Table 7 shows the raw data for this hypothesis. Table 8 shows the summary data and P values for this hypothesis. The Analysis of Variance indicates there is no statistical evidence to suggest a causal relationship between a school having a diagnosis of Sick Building Syndrome and its percentage of students requiring prophylactic medications.
Table 7

Raw Data on the Percentage of Students Receiving Prophylactic Medications in the Selected Schools During the Years Studied

<table>
<thead>
<tr>
<th>Pairs</th>
<th>90-91</th>
<th>91-92</th>
<th>92-93</th>
<th>93-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S</td>
<td>NA</td>
<td>6.8%</td>
<td>7.8%</td>
<td>11%</td>
</tr>
<tr>
<td>1NS</td>
<td>4.8%</td>
<td>5.2%</td>
<td>8.7%</td>
<td>10.7%</td>
</tr>
<tr>
<td>2S</td>
<td>5.2%</td>
<td>9%</td>
<td>13.6%</td>
<td>13.3%</td>
</tr>
<tr>
<td>2NS</td>
<td>5.6%</td>
<td>8.4%</td>
<td>10.8%</td>
<td>9.6%</td>
</tr>
<tr>
<td>3S</td>
<td>4.9%</td>
<td>7.4%</td>
<td>12.5%</td>
<td>7.3%</td>
</tr>
<tr>
<td>3NS</td>
<td>4.4%</td>
<td>6.7%</td>
<td>17.5%</td>
<td>12.7%</td>
</tr>
<tr>
<td>4S</td>
<td>5.2%</td>
<td>5.6%</td>
<td>NA</td>
<td>6.7%</td>
</tr>
<tr>
<td>4NS</td>
<td>6.8%</td>
<td>4.8%</td>
<td>10%</td>
<td>9.2%</td>
</tr>
<tr>
<td>5S</td>
<td>3.3%</td>
<td>10.1%</td>
<td>6.2%</td>
<td>9.3%</td>
</tr>
<tr>
<td>5NS</td>
<td>4.1%</td>
<td>10.2%</td>
<td>8.2%</td>
<td>9.8%</td>
</tr>
<tr>
<td>6S</td>
<td>6.5%</td>
<td>10.1%</td>
<td>10%</td>
<td>12.8%</td>
</tr>
<tr>
<td>6NS</td>
<td>6.2%</td>
<td>11.9%</td>
<td>11.4%</td>
<td>16.3%</td>
</tr>
<tr>
<td>7S</td>
<td>4.7%</td>
<td>2.5%</td>
<td>6.6%</td>
<td>10.9%</td>
</tr>
<tr>
<td>7NS</td>
<td>1.6%</td>
<td>4.8%</td>
<td>8.9%</td>
<td>5.4%</td>
</tr>
<tr>
<td>8S</td>
<td>1.1%</td>
<td>.6%</td>
<td>.9%</td>
<td>.9%</td>
</tr>
<tr>
<td>8NS</td>
<td>.09%</td>
<td>.2%</td>
<td>.15%</td>
<td>.24%</td>
</tr>
</tbody>
</table>
Table 8

Summary Data for the Percentage of Students Taking Prophylactic Medications for the Selected Schools During the Years Studied

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sick</td>
<td>4.3</td>
<td>7.5</td>
<td>9.7</td>
<td>10.4</td>
</tr>
<tr>
<td>Not Sick</td>
<td>4.3</td>
<td>6.7</td>
<td>9.6</td>
<td>9.5</td>
</tr>
</tbody>
</table>

p value for S/NS (main effect) = .77
p value for S/NS (interaction effect) = .92
Mean Squares = .82  \( F = .16 \)

Hypothesis 5: The percentage of staff turnover in schools having a diagnosis of Sick Building Syndrome will be significantly greater than the percentage of staff turnover in schools which were not identified as being "sick."

Table 9 shows the raw data for this hypothesis. Table 10 shows the summary data and p values for this hypothesis. Analysis of Variance indicates there is no statistical evidence to suggest a causal relationship between a school having a diagnosis of Sick Building Syndrome and its percentage of staff turnover.
Table 9

Raw Data on the Percentage of Staff Turnover in the Schools Selected for the Years Studied

<table>
<thead>
<tr>
<th>Pairs</th>
<th>90-91</th>
<th>91-92</th>
<th>92-93</th>
<th>93-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S</td>
<td>NA</td>
<td>100%</td>
<td>2%</td>
<td>11.5%</td>
</tr>
<tr>
<td>1NS</td>
<td>2.9%</td>
<td>14.3%</td>
<td>8.6%</td>
<td>3%</td>
</tr>
<tr>
<td>2S</td>
<td>13.5%</td>
<td>10%</td>
<td>4.9%</td>
<td>11.2%</td>
</tr>
<tr>
<td>2NS</td>
<td>12.2%</td>
<td>9.3%</td>
<td>17.5%</td>
<td>10%</td>
</tr>
<tr>
<td>3S</td>
<td>12.3%</td>
<td>3.9%</td>
<td>2.1%</td>
<td>7.8%</td>
</tr>
<tr>
<td>3NS</td>
<td>15.8%</td>
<td>2.6%</td>
<td>5.6%</td>
<td>4.9%</td>
</tr>
<tr>
<td>4S</td>
<td>12.3%</td>
<td>7.4%</td>
<td>6.3%</td>
<td>10.2%</td>
</tr>
<tr>
<td>4NS</td>
<td>7.9%</td>
<td>7.7%</td>
<td>0%</td>
<td>15.6%</td>
</tr>
<tr>
<td>5S</td>
<td>7.1%</td>
<td>6.5%</td>
<td>8.5%</td>
<td>6.9%</td>
</tr>
<tr>
<td>5NS</td>
<td>0%</td>
<td>0%</td>
<td>2.6%</td>
<td>8.5%</td>
</tr>
<tr>
<td>6S</td>
<td>8.3%</td>
<td>15.2%</td>
<td>7.0%</td>
<td>10%</td>
</tr>
<tr>
<td>6NS</td>
<td>12.2%</td>
<td>17.3%</td>
<td>4.1%</td>
<td>10%</td>
</tr>
<tr>
<td>7S</td>
<td>9.8%</td>
<td>14.4%</td>
<td>8.7%</td>
<td>3.1%</td>
</tr>
<tr>
<td>7NS</td>
<td>9.5%</td>
<td>11.5%</td>
<td>6.4%</td>
<td>9.1%</td>
</tr>
<tr>
<td>8S</td>
<td>7.3%</td>
<td>7.9%</td>
<td>2.7%</td>
<td>3.8%</td>
</tr>
<tr>
<td>8NS</td>
<td>1.7%</td>
<td>5.9%</td>
<td>4.0%</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

School 1S opened in the fall of 1992 accounting for the 100% turnover. It drew a large part of its staff from School 6NS when the principal for 6NS became the principal for 1S. The opening of middle schools and the subsequent transfer of the sixth grade and many sixth grade teachers from the elementary sites may have contributed to the percentages reflected for the 1991-92 school year.
Table 10

Summary Data for the percentage of Staff Turnover for the Selected Schools for the
Years Studied

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sick</td>
<td>10.1</td>
<td>9.3</td>
<td>5.7</td>
<td>7.6</td>
</tr>
<tr>
<td>Not Sick</td>
<td>7.8</td>
<td>8.6</td>
<td>6.1</td>
<td>7.9</td>
</tr>
</tbody>
</table>

p value for S/NS (main effect) = .67
p value for S/NS (interaction effect) = .80
Mean Squares = 5.8 F = .34

Hypothesis 7: There will be a significantly higher percentage of suspensions and recommendations for expulsion in schools having a diagnosis of SBS than the percentage of suspensions and recommendations for expulsion in schools which were not identified as being "sick."

Table 11 shows the raw data for the percentage of short term suspensions. Table 12 shows the summary data and p values for this portion of this hypothesis. Analysis of Variance indicates there is no statistical evidence to suggest a relationship between a school having a diagnosis of Sick Building Syndrome and its percentage of short term suspensions.
Table 11

**Raw Data on the Percentage of Short Term Suspension (less than 10 days) by School for the Selected Schools for the Years Studied**

<table>
<thead>
<tr>
<th>Pairs</th>
<th>90-91</th>
<th>91-92</th>
<th>92-93</th>
<th>93-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S</td>
<td>NA</td>
<td>.5%</td>
<td>2.3%</td>
<td>1.9%</td>
</tr>
<tr>
<td>1NS</td>
<td>NA</td>
<td>7.7%</td>
<td>10.2%</td>
<td>11.6%</td>
</tr>
<tr>
<td>2S</td>
<td>NA</td>
<td>1.9%</td>
<td>2.5%</td>
<td>13.4%</td>
</tr>
<tr>
<td>2NS</td>
<td>NA</td>
<td>8.1%</td>
<td>14.4%</td>
<td>24.9%</td>
</tr>
<tr>
<td>3S</td>
<td>NA</td>
<td>1.1%</td>
<td>2.8%</td>
<td>1%</td>
</tr>
<tr>
<td>3NS</td>
<td>NA</td>
<td>4.5%</td>
<td>5.7%</td>
<td>5.1%</td>
</tr>
<tr>
<td>4S</td>
<td>NA</td>
<td>6%</td>
<td>45.7%</td>
<td>17.8%</td>
</tr>
<tr>
<td>4NS</td>
<td>NA</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>5S</td>
<td>NA</td>
<td>9.6%</td>
<td>20.9%</td>
<td>9.9%</td>
</tr>
<tr>
<td>5NS</td>
<td>NA</td>
<td>2.7%</td>
<td>5.6%</td>
<td>4.9%</td>
</tr>
<tr>
<td>6S</td>
<td>NA</td>
<td>4.5%</td>
<td>9.3%</td>
<td>12.7%</td>
</tr>
<tr>
<td>6NS</td>
<td>NA</td>
<td>5.2%</td>
<td>5%</td>
<td>8.8%</td>
</tr>
<tr>
<td>7S</td>
<td>62.8%</td>
<td>64.7%</td>
<td>47.1%</td>
<td>89.5%</td>
</tr>
<tr>
<td>7NS</td>
<td>74.8%</td>
<td>87.25%</td>
<td>57.9%</td>
<td>59.3%</td>
</tr>
<tr>
<td>8S</td>
<td>60.5%</td>
<td>55.7%</td>
<td>36.6%</td>
<td>45.2%</td>
</tr>
<tr>
<td>8NS</td>
<td>75.7%</td>
<td>178.2%</td>
<td>75.2%</td>
<td>130%</td>
</tr>
</tbody>
</table>

The radical changes in the data from school 4S are puzzling. The enrollment in this school dropped from 1,132 to 852 from school year 1991-92 to school year 1992-93 and yet the number of short term suspensions increased from 68 to 390. The principal remained the same for these two years but one of the two assistant principals changed. During the 1993-94 school year a Saturday Detention Program was
instituted at this school. This program may account for the reduction in the number of out-of-school suspensions during the 1993-94 school year when the number was reduced by more than 50%.

The middle and high school data (7S, 7NS, 8S, 8NS) for the 93-93 school year appear irregular. There was a reorganization in the Office of School Leadership at this time, and the data were not collected in accordance with the same descriptors.

Table 12 shows the raw data for the percentage of long term suspensions for the selected schools for the years studied. Table 13 shows the summary data and P values for this hypothesis. Analysis of Variance indicates there is no statistical significance to suggest a causal relationship between a school having a diagnosis of Sick Building Syndrome and its percentage of short term suspensions.

Table 12

Summary Data for the Percentage of Short Term Suspensions (less than 10 days) by School for the Selected Schools for the Years Studied

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sick</td>
<td>61.7</td>
<td>60.2</td>
<td>41.9</td>
<td>67.4</td>
</tr>
<tr>
<td>Not Sick</td>
<td>75.3</td>
<td>132.8</td>
<td>66.6</td>
<td>94.7</td>
</tr>
</tbody>
</table>

p for S/NS (main effect) = .29
p for S/NS (interactive effect) = .37
Mean Squares = 677.5  F = 1.24
Table 13 shows the raw data for the long term suspension portion of this hypothesis. Table 14 shows the summary data and p values for the long term suspension portion of this hypothesis. Analysis of Variance indicates there is no statistical evidence to suggest a causal relationship between a school having a diagnosis of Sick Building Syndrome and its percentage of long term suspensions.

Table 13

Raw Data on the Percentage of Long Term (10 or more days) Suspensions by School for the Selected Schools for the Years Studied

<table>
<thead>
<tr>
<th>Pairs</th>
<th>90-91</th>
<th>91-92</th>
<th>92-93</th>
<th>93-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1NS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2S</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.09%</td>
</tr>
<tr>
<td>2NS</td>
<td>0</td>
<td>0</td>
<td>.76%</td>
<td>0</td>
</tr>
<tr>
<td>3S</td>
<td>0</td>
<td>0</td>
<td>.76%</td>
<td>0</td>
</tr>
<tr>
<td>3NS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4S</td>
<td>0</td>
<td>0</td>
<td>.12%</td>
<td>.22%</td>
</tr>
<tr>
<td>4NS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5S</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5NS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6S</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6NS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7S</td>
<td>0</td>
<td>0</td>
<td>.20%</td>
<td>.14%</td>
</tr>
<tr>
<td>7NS</td>
<td>0</td>
<td>.625%</td>
<td>.12%</td>
<td>.07%</td>
</tr>
<tr>
<td>8S</td>
<td>.08%</td>
<td>0</td>
<td>.75%</td>
<td>1.25%</td>
</tr>
<tr>
<td>8NS</td>
<td>0</td>
<td>0</td>
<td>.15%</td>
<td>2.0%</td>
</tr>
</tbody>
</table>
Table 14

Summary Data for the Percentage of Long Term Suspensions (10 or more days) by School for the Selected Schools for the Years Studied

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sick</td>
<td>.01</td>
<td>0</td>
<td>.13</td>
<td>.21</td>
</tr>
<tr>
<td>Not Sick</td>
<td>7.0</td>
<td>.08</td>
<td>.13</td>
<td>.26</td>
</tr>
</tbody>
</table>

p value for S/NS (main effect) = .77
p value for S/NS (interactive effect) = .97
Mean Squares = .01  F = .07

Table 15 shows the raw data for the recommendations for expulsion portion of this hypothesis. Table 16 shows the summary data and p values for the recommendations for expulsion portion of this hypothesis. Analysis of Variance indicates there is no statistical evidence to suggest a causal relationship between a school having a diagnosis of Sick Building Syndrome and its percentage of recommendations for expulsion.
Table 15

<table>
<thead>
<tr>
<th>Pairs</th>
<th>90-91</th>
<th>91-92</th>
<th>92-93</th>
<th>93-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1NS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2S</td>
<td>.13%</td>
<td>.13%</td>
<td>0</td>
<td>.09%</td>
</tr>
<tr>
<td>2NS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3S</td>
<td>.08%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3NS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4S</td>
<td>.15%</td>
<td>0</td>
<td>.36%</td>
<td>.22%</td>
</tr>
<tr>
<td>4NS</td>
<td>.38%</td>
<td>0</td>
<td>.23%</td>
<td>0</td>
</tr>
<tr>
<td>5S</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5NS</td>
<td>.48%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6S</td>
<td>.11%</td>
<td>.22%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6NS</td>
<td>.44%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7S</td>
<td>.79%</td>
<td>.82%</td>
<td>.62%</td>
<td>.49%</td>
</tr>
<tr>
<td>7NS</td>
<td>.79%</td>
<td>1.06%</td>
<td>.89%</td>
<td>1.9%</td>
</tr>
<tr>
<td>8S</td>
<td>.21%</td>
<td>.74%</td>
<td>.58%</td>
<td>.81%</td>
</tr>
<tr>
<td>8NS</td>
<td>.47%</td>
<td>.92%</td>
<td>.3%</td>
<td>.5%</td>
</tr>
</tbody>
</table>
Table 16

Summary Data for the Percentage of Recommendations for Expulsion for the Selected Schools for the Years Studied

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sick</td>
<td>.18</td>
<td>.24</td>
<td>.20</td>
<td>.20</td>
</tr>
<tr>
<td>Not Sick</td>
<td>.32</td>
<td>.25</td>
<td>.18</td>
<td>.30</td>
</tr>
</tbody>
</table>

p value for S/NS (main effect) = .75
p value for S/NS (interactive effect) = .67
Mean Squares = .02 F = .53

Hypothesis 8: In schools having a diagnosis of SBS, staff attendance, student ADA and students’ mean standardized test scores for reading and math will show a significant decrease and staff turnover will show a significant increase following the public announcement that a school has been identified as being "sick."

This hypothesis had to be modified to exclude staff attendance as a factor due to the absence of an accessible data base for the records requested. No statistical evidence was found to suggest a relationship between the public announcement that a school had been identified as being "sick" and student ADA, students’ mean standardized test scores for reading and math or staff turnover.

Summary of Statistical Hypotheses
Eight hypotheses were proposed for this study. Hypotheses 1 and 6 had to be abandoned and hypotheses 8 had to be modified due to the unavailability and lack of reliability of the data needed.

Problems with reliable data were not present for Hypothesis 7 which dealt with suspensions and recommendations for expulsion. Records of all students referred at this level of intervention were forwarded to the Office of School Leadership where monthly reports reflecting each school's profile were compiled, disseminated and maintained in hard copy format for the years in question.

All data prepared for analysis were felt to be accurate and pertinent to the study. Hypotheses were abandoned if any compromise in the reliability of raw data was suspected. All hypotheses in this study were found to be statistically insignificant.
Chapter 5: Conclusions

Introduction

Sick Building Syndrome is a documented reality. Those susceptible to the effects of life in a building having an SBS diagnosis experience symptoms ranging from discomfort to debilitation.

Using matched pairs of schools identified as having an SBS diagnosis and those not identified as having the diagnosis, this study examined the relationship between factors assumed or determined to have an impact on a school’s ability to carry out its mission as they related to a diagnosis of Sick Building Syndrome (SBS). The factors studied were student attendance (ADA); students’ mean standardized test scores in math and reading comprehension; the need for students to take prophylactic medications; the rate of staff turnover; the percentages of referrals for short term suspensions, long term suspensions and recommendations for expulsion; as well as the impact of the public identification of a school as having a diagnosis of SBS on student attendance, students’ standardized test scores and staff turnover.

Limitations

The results of this study should be considered in the light of the following limitations.

The sample of schools was limited to eight "sick" schools and eight schools which were not identified as being "sick." All were within the same school division. The identification took the form of a verification by Dr. James Woods of Virginia...
Polytechnic Institute following a sharing by the school division of the pattern of complaints from students and staff. All schools identified as "sick" met the IAQ Standard of "significantly more than 20% of a building's occupants complain[ing] of such symptoms as headaches, eye irritation, fatigue, and dizziness for more than two weeks. The symptoms are relieved when the occupant leaves the building and no specific cause of the problem can be identified" (Gardner, 1991, p.30). Although care was taken in selecting the matching schools, none of the schools "not identified as being 'sick'" was ever given a clean bill of health. Although there were no patterns of complaints consistent with the Indoor Air Quality Standards qualifying a building as having SBS, the schools used in the pairings might very well have been less than healthy in some area.

The study was limited to schools having an HVAC related SBS diagnosis. SBS in general, and Sick School Syndrome, in particular, can have many origins. Recently, research was done at Texas Women's University to establish some ecological guidelines for a healthful school building. In this study, the Delphi Technique was used to design a series of three questionnaires. Sixty environmental specialists from twenty-six states and two other countries participated in the study; giving their opinions on the construction and maintenance of healthful school buildings. They agreed on ten major areas of concern listed below in their order of importance:

1. heating, cooling and ventilation
2. pest controls
3. cleaning products
4. chemicals
5. fragrances
6. site selection
7. lighting
8. remodeling the school building
9. floors
10. art supplies (Miller, 1995, p.64).

It could very well be that all of the buildings studied were less than healthful. Similarly, it could also be that, though the "sick" schools clearly met the IAQ Standards, they were not different enough from the schools not identified as being "sick" to reveal any significant differences.

Hypothesis 5 dealt with behavior referrals for administrative intervention. It targeted those students whose behavior was enough out-of-the-ordinary to warrant intervention beyond that of the classroom teacher via his/her routine classroom management program, but it was not looking at infractions serious enough to warrant a suspension or recommendation for expulsion.

Conclusions

Based on the results of this study, there is no statistical significance to suggest a relationship between a school having a diagnosis of SBS and its ability to carry out its mission as measured by the variables investigated.
Should the replication of any aspect of this study be attempted, the following questions and suggestions are offered to assist in refining the selection and collection of data. Perhaps a more precise re-examination would reveal statistically significant differences.

**Hypothesis 1:**

The percentage of staff absences in schools having a diagnosis of SBS will be significantly greater than the percentage of staff absences in schools which were not identified as being "sick."

This hypothesis had to be abandoned because the data base used to document staff absences had been established to follow the employee rather than the employment site. Once a school year had ended, and the staff had been transferred for the subsequent year, the data could not be re-configured to provide this researcher with the staff absence patterns by school for the years under study. The loss of this hypothesis is felt to be significant.

A future study should examine staff absence rates for those individual staff members deemed to suffer from the effects of SBS before and after a transfer to/from a school identified as being "sick." It should also compare those who are susceptible within a given identified "sick" building to those who are not susceptible. One might also want to look at the patterns of staff absences. Teachers are known to be a dedicated lot, and many would rather come to school feeling sick than prepare for a substitute or make up for the lost teaching opportunities associated with having a
substitute. In buildings having a diagnosis of SBS, do those without direct responsibility for students define the need to be absent more readily?

**Hypothesis 2:**

The average daily attendance (ADA) in schools having a diagnosis of SBS will be significantly lower than the ADA in schools which were not identified as being "sick."

The majority of schools studied herein, 12 of 16, were elementary schools. At the elementary level, a student is considered present for ADA purposes if s/he shows up for school. Children are often sent home during the school day because of illnesses that arise after the child has arrived at school. It would be interesting to look at the percentage of students sent home for illness at schools with a diagnosis of SBS and schools not identified as being "sick." It might also be interesting to configure a different type of study which addresses how a child determines that s/he does not feel well. Young children may not have a baseline understanding for "feeling good," and therefore, may not identify "feeling badly" unless there is some overt association with illness such as pain, vomiting, etc. Children who feel poorly only at school may also be mis-diagnosed as having school-phobia or school-anxiety; especially if their symptoms are SBS related and disappear when they leave the "sick" building.

**Hypothesis 3:**

Students’ mean standardized test scores for math and reading comprehension in schools having a diagnosis of SBS will be significantly lower than students’ mean
standardized test scores for math and reading comprehension in schools which were not identified as being "sick."

Historically, mean test performance at a given grade level for a given year has been compared to mean test performance at the same grade level for subsequent years. These comparisons have been touted as evidence of a school’s or teacher’s performance. Because the population being evaluated each year is different, it is an inappropriate comparison. It would be more valuable to conduct a longitudinal study on the same population. A function of that study could be to track students who were susceptible to the effects of SBS as they moved from schools identified as having SBS to schools not identified as being "sick," in an effort to determine if their achievement improved with the change in setting. Such moves could be a function of intentional transfers for the purpose of escaping an SBS environment or the natural movement from elementary to middle to high school settings when the health of the buildings differ.

**Hypothesis 4:**

There will be a significantly greater percentage of students taking prophylactic medications in schools having a diagnosis of SBS than the percentage of students taking prophylactic medications in schools which were not identified as being "sick."

The question remains as addressed in Chapter 2 of this study: Are students on prophylactic medications at an advantage because of the stimulant nature of most of such medications prescribed for school aged children?
Hypothesis 5:

The percentage of staff turnover in schools having a diagnosis of SBS will be significantly greater than the percentage of staff turnover in schools which were not identified as being "sick."

The fact that the selected school division loosened transfer procedures about the time SBS related symptoms were authorized for guaranteed involuntary transfer status may have had an impact on the overall percentages for this hypothesis. Would statistical significance exist if only the percentages of involuntary transfers had been reviewed? Such a data base did not exist at the time of this study. Accessing the information would have required a more invasive procedure.

Hypothesis 6:

There will be a significantly greater percentage of behavior referrals for administrative intervention in schools having a diagnosis of SBS than the percentage of behavior referrals for administrative intervention in schools which were not identified as being "sick."

The need to abandon this hypothesis because of inconsistencies in the collection and maintenance of data across the schools studied also represented a great loss. Factors such as teachers' tolerance thresholds and the capturing of students within two standard deviations of the mean might have been revealed and resulted in statistically significant results. This researcher feels that this hypothesis, in particular, bears re-visiting now that the record maintenance procedures are clearly established as a computer data base.
Hypothesis 7:

There will be a significantly higher percentage of suspensions and recommendations for expulsion in schools having a diagnosis of SBS than the percentage of suspensions and recommendations for expulsion in schools which were not identified as being "sick."

The data concerning short term (less than 10 days) suspensions may have been affected by the presence of Saturday Detention programs at some schools. This would be true for the type of borderline offenses which require a serious intervention but are not offenses outlined in the Code of Student Conduct as requiring a mandatory suspension. An interesting question might be whether the schools implementing a Saturday Detention Program did so in order to reduce the number of short term suspensions. If so, then the Saturday Detention figures might uncover the population originally targeted by this hypothesis.

The percentage of students receiving long term suspensions (10 or more days) and recommendations for expulsion reflects those who have committed offenses of a very serious nature. In a normal distribution these data would reflect those students falling more than two standard deviations below the mean. It was no surprise that these data revealed no statistically significant relationship as outlined in the hypothesis.

A possible interpretation suggests that SES may have had an effect on the outcomes for this hypothesis. The table on page 44 of this study reveals that a close matching was not achieved for this criterion. Since research shows that SES does
affect academic achievement, and all but one of the schools identified as not "sick" represented lower SES populations, it is possible that the SBS factor did depress the test scores of the populations from higher SES schools causing no statistical evidence to be revealed. A random assignment of the schools to pairs may or may not have made a difference. In this school division, the newer SBS-identified schools serve newer, more homogeneous neighborhoods; and the older, not identified schools are in the more established areas of the city where larger pockets of poverty are more likely to exist.

**Hypothesis 8:**

In schools having a diagnosis of SBS, staff attendance, student ADA, and mean standardized test scores for math and reading comprehension will show a significant decrease following the public announcement that the school has been identified as being "sick."

It was a surprise to learn that there was no statistical significance in this area. The attention an SBS diagnosis receives and resulting community response could have easily fostered an over-reaction to perceived effects of a school’s ability to fulfill the expectations of its publics. The basis for this entire study was a result of this researcher’s perception that her community needed an answer to the question: Does poor indoor air quality or "Sick Building [School] Syndrome" negatively affect a school’s ability to carry out its mission?
Implications for Further Study

Perhaps the key word is susceptibility. Quite possibly, across our population, the percentage of individuals susceptible to the effects of SBS is no more prevalent than the percentage of individuals susceptible to other allergens.

Additional research might include the following questions. If a "sick" school has portable classrooms, are those staff housed in the portables more or less likely to be absent? Are more staff members absent on Friday when the reaction has built up than on Monday when absence from the "sick" environment has caused symptoms to dissipate?

Implications of the Study

Publishing the results of this study should inform school divisions which are sincerely trying to address their routine sick building syndrome needs as they relate to HVAC conditions. More care can be taken to discover permanent solutions, design training packages and prevent the recurrence of the conditions. There should be less of a tendency to deny the existence of the problem in light of the implication that one's vulnerability to an SBS environment is a function of one's susceptibility to an allergic reaction to the stimuli present. Knowing that an entire school would not have to be closed, School Boards might be more likely to open the doors to transfer opportunities for staff and students who suffer in buildings identified as "sick."

Implications for Legislation:

The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), the Environmental Protection Agency (EPA), the National
Institute for Occupational Safety and Health (NIOSH), and the Occupational Safety and Health Administration (OSHA) sometimes set standards for "tolerated or safe" levels of gases and other air pollutants. Although these standards are designated for healthy males in workplaces, and not for children in schools, they do serve as guidelines (Rapp, 1995, p.10). There is a recognized medical illness referred to as "multiple chemical sensitivity" which has been acknowledged by the federal government through The Americans With Disabilities Act (ADA). In synthesizing these two, one concludes that it is not the accepted "tolerated or safe" level which is critical, but the level at which symptoms are triggered (Rapp, 1995, p.11). Buildings which clearly meet the standards may not, in fact, meet the needs of their student populations.

A condition that is recognized in ADA can become costly and warrants the attention of legislative bodies. The cost of implementing 504 Plans for all students who suffer from "multiple chemical sensitivity" can be prohibitive. It's one thing for a large school division to offer a transfer to another within its division, but a 504 Plan might force a smaller division to pay tuition for out-of-zone education, provide transportation, pay for a home schooling tutor or absorb the cost of an allergen-free environment within the neighborhood school.

Those bodies responsible for setting standards would do well to establish standards suitable for school buildings that are more stringent than those established for adult males in their workplaces. Legislative support for those standards could
then bring the necessary monies to the local education agencies trying to meet the needs of their unique student populations without draining general education funds.

**Implications for School Administrators:**

Administrators should be able to deal more openly and honestly with concerns expressed about SBS issues. The literature is consistent in its acknowledgment that SBS is a real condition that can have devastating effects on individuals. Discovering that not all individuals are so seriously affected and that the overall mission of the school may not be hampered, administrators are freer to respond to individual needs without fearing contagion.

There is also a body of information that should become a part of building administrators' working knowledge. Building specific maintenance issues can no longer be trusted to the head custodian. The principal needs to understand the implications of a poorly maintained HVAC system and insure that his budget reflects attention to such details. Sources of a sick building condition extend far beyond the HVAC issues explored in this study. Many found in the listing earlier in this chapter can be controlled if the principal understands them and works with his staff to take the necessary precautionary measures. The principal also needs to alert his teaching staff to the symptoms associated with a student's hypersensitivity to environmental stimuli and make certain that such students' individual needs are addressed.

**Summary**

This study suggests that SBS of a possible HVAC origin may not be disruptive to the operation of a school as it carries out its mission. It does not deny the fact that
individuals' responses to stimuli within that environment can be very real and even debilitating. Knowing that the school, as a whole, is not being negatively affected, the focus can be turned to the individuals and their needs. The National Research Council reported in 1992 that, "Once an individual becomes sensitized to indoor allergens, the sensitization may become irreversible" (Franks, 1995, p.323).

The possibility remains that while this study did not show statistical significance for the hypotheses tested, very real problems exist for those individuals susceptible to the effects of Sick Building Syndrome. The reality of the condition is not likely to go away, and an informed and accountable reaction on the part of those entrusted with the education of our youth has become necessary. A closer look at the hypotheses which had to be abandoned may provide the insight and guidance needed to act in a responsible manner on behalf of the publics served.
Appendix

James E. Woods, Ph.D.
Professor of Building Construction
Director, Center for Building, Health, Safety and Productivity

James E. Woods, Ph.D., P.E., has been since 1989 the William E. Jamerson Professor of Building Construction in the College of Architecture and Urban Studies. In November 1991, he became director of the indoor environment program and is now director of the Center for Building Health, Safety and Productivity at Virginia Polytechnic and State University at Falls Church, Virginia.

Dr. Woods is president of the International School on Indoor Air Sciences. He has researched, taught, and practiced in the field of environmental control for more than thirty years. Dr. Woods has authored and co-authored more than 100 technical papers and four books on indoor air quality and energy conservation. He is also co-holder of two patents - one on a contamination control device and the other on a solar collector.

Previously, Dr. Woods was a senior engineering manager for Honeywell, where he was responsible for the technical direction of indoor air quality diagnostics. Prior to his work at Honeywell, he was professor in the departments of Mechanical Engineering and Architecture and the director of the Center for Advancement of Building Technologies and the Building Energy Utilization Laboratory at Iowa State University.

Dr. Woods earned his B.S. in mechanical engineering from the University of New Mexico, 1962; his M.S. in psychological sciences from Kansas State University, 1971; and his Ph.D. in mechanical engineering from Kansas State University, 1974. He is a registered professional engineer and a class A energy auditor.

Currently, Dr. Woods is active in four professional societies: 1) American Society of Heating, Refrigerating, and Air Conditioning Engineers as a member of several technical and standard projects committees which pertain to thermal and ventilation requirements and systems. Elected as a fellow in January 1992. 2) American Society of Testing and Materials on the Indoor Air Subcommittee of D22: Sampling and Analysis of Atmospheres. 3) International Society of Indoor Air Quality and Climate. 4) International Academy of Indoor Air Sciences. He also has served as a member of the Science Advisory Board for the U.S. Environmental Protection Agency; Technical Advisory Committee for the American Lung Association; Science Advisory Committee for the Center for Indoor Air Research and a member of the National Research Council of the National Academy of Sciences, National Academy of Engineering and Institute of Medicine. He was also a member of the National Research Council’s Committee on Indoor Air Pollutants.
Dr. Woods has been responsible for more than 15 major research projects. These were funded by sources such as Union Carbide Chemical & Plastics Corp.; Phillip Morris Corp.; American Hospital Association; U.S. Department of Energy; Minnesota Department of Energy and Economic Development; Douglas Aircraft Co.; Iowa Energy Policy Council; and the American Society of Heating, Refrigerating, and Air Conditioning Engineers. Dr. Woods testified in U.S. Senate and House hearings five times in the last eleven years regarding research needs for building environments. He served as an expert witness in twenty administrative hearings and various court cases, including ten depositions and testimonies at four jury trials regarding environmental control, indoor air quality, and occupant exposure within buildings (Woods, 1996).


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Abstract

THE IMPACT OF SICK BUILDING SYNDROME ON SELECTED VARIABLES ASSOCIATED WITH SCHOOL EFFECTIVENESS

Chairperson: Professor Robert J. Hanny

The purpose of this study was to investigate the relationship between schools having a diagnosis of Sick Building Syndrome (SBS) and their ability to carry out their mission. The author also hoped to determine if the public announcement of an SBS diagnosis had any impact on the factors being measured.

Sixteen public schools from a single school division were studied for this project. Eight schools having a diagnosis of SBS related to Heating, Ventilation and Air Conditioning (HVAC) factors were matched to eight schools which were not identified as being sick and had no known potential for the diagnosis. The eight "sick" schools were identified by Dr. James Woods of Virginia Polytechnic Institute. A public announcement of the diagnoses was made in November of 1992. The criteria used for selecting the matching schools included the schools' percentages of free and reduced lunch eligibilities, the schools' mobility indices, the instructional level, and the ethnic balance. No school that had been built or undergone a major renovation since 1975 was considered for matching.

Six factors which were assumed or determined to have a relationship to a school's ability to carry out its mission were examined. They were student average daily attendance (ADA), students' mean standardized test scores in math and reading on the Iowa Tests of Basic Skills and the Tests of Achievement and Proficiency, the rate of staff turnover and the percentages of short term suspensions, long term suspensions, and recommendations for expulsion. The study also examined the impact of the public identification of a school as "sick" on student ADA, students' mean standardized test scores in math and reading and staff turnover. Four years of data were used.

A factorial ANOVA model (2 by 4) for repeated measures revealed no statistical significance for main or interaction effects on any of the hypotheses addressed.

Further study is suggested to ascertain if either of the abandoned hypotheses, the number of behavioral referrals for administrative intervention, or the percentage of staff absences might reveal more statistically significant findings.
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