AN EVALUATION OF THE EFFECTIVENESS OF SCHOOL BUILDING PROCEDURES IN ASSURING SAFE FACILITIES AND RECOMMENDATIONS FOR MODICFICATION OF PROCEDURES

SEISMIC SAFETY ADVISORY COUNCIL

STATE OF UTAH

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SEISMIC SAFETY ADVISORY COUNCIL STATE OF UTAH

Prepared By

Delbert B. Ward Executive Director Seismic Safety Advisory Council

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The Utah Seismic Safety Advisory Council, established in 1977 by legislative action, is charged to prepare assessments of earthquake hazards and associated risks to life and property in the State of Utah, and to make recommendations for reducing earthquake risks when hazardous conditions are observed.

In this report, procedures currently followed in building schools are evaluated from the perspective of earthquake safety. The report identifies procedures and policies which affect earthquake safety in the construction of school buildings, and furnishes recommendations for changes in those procedures that are believed would improve and strengthen them to give greater assurance that the buildings are designed and built in accordance with codes and standards for earthquake safety that have been adopted.

The findings and recommendations resulting from this study are reinforced by findings from a parallel investigation of a new school addition recently approved for construction. In the instance of this example school building, it is shown that, as a result of deficiencies in the procedures, it is possible today for schools to be built that are not in compliance with adopted codes, in particular codes pertaining to earthquake safety. It is the view of members of the Seismic Safety Advisory Council that school buildings, as a minimum, should meet state-of-the-art safety standards, and that when procedures intended to safeguard against potentially unsafe school buildings are discovered, the procedures should be modified promptly so that their purposes are optimally fulfilled.

The Seismic Safety Advisory Council was given specific statutory responsibilities under the law by which it was created. Those pertaining directly or indirectly to earthquake safety of school buildings include the following.

- 1. To recommend a consistent policy framework for seismic safety in the State of Utah.
- 2. To recommend Statewide and local programs to reduce earthquake hazards.
- 3. To recommend methods for improving building standards and construction compliance with standards and for the siting and design of important facilities, including hospitals and schools.

The findings and recommendations contained in this report are directed mostly to practices and procedures pertaining to new school construction. The earthquake safety of existing schools is the subject of a separate report prepared by the Advisory Council.

The Seismic Safety Advisory Council urges adoption and implementation of the recommendations contained herein.

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SECTION 1

INTRODUCTION

Utah law provides that school buildings are to be constructed in compliance with adopted codes and in a manner to safeguard the life and health of occupants. The State Superintendent of Public Instruction, by law, is authorized and required to approve plans for new school construction, except those for cities of the first class, as a means to insure that standards adopted by the Office of Education are met.

The Seismic Safety Advisory Council has concluded that earthquake safety is one component of school building safety, and this view apparently is consistent with the view of the Office of Education, for the adopted code includes earthquake safety provisions.

As a part of its legislative charge, the Seismic Safety Advisory Council has reviewed earthquake risks to school buildings in Utah during the past several years. Such review has included seismic hazards evaluations of existing school buildings and appropriate levels of seismic resistance for new school building construction. In this report, discussion is limited to new building construction.

A conclusion reached relatively early in assessment of new school building construction is that current earthquake safety standards that are contained in the code adopted by the Office of Education are adequate for Utah's earthquake environment. Having reached this conclusion, the Advisory Council then turned its attention to an evaluation of school building procedures in order to determine how effectively the adopted earthquake safety standards are incorporated into new school construction.

Initial reviews of school building procedures by Council staff provided an indication that they might not be effective in assuring the presence of earthquake resistance in every instance of new school construction. Two observations provided this indication. One observation was that nowhere in the procedures was review of earthquake provisions undertaken before plans were approved. The other observation was that several schools under construction appeared not to be in compliance with certain earthquake safety provisions of applicable codes. This initial indication of possible failure to achieve proper earthquake resistance in new school construction was reinforced several months later when a specific school building project came to the attention of the Seismic Safety Advisory Council. Plans for that specific building had been approved after all pertinent reviews were completed, yet separate analysis by staff of the Seismic Safety Advisory Council indicated non-compliance with earthquake safety provisions of adopted codes. The fact that at least one school building in the State could be built and likely be substandard (here taken to mean not in compliance with codes for earthquake safety) suggests that the school building procedures established by the State are not fully effective.

A special committee of the Seismic Safety Advisory Council was formed for the purpose of verifying that the subject school project was deficient and, based upon those findings, to suggest changes in school building procedures, if any are needed, which might provide greater assurance that earthquake-safe schools are constructed. In this report, the findings of that special study committee are summarized, suggestions for improved school building procedures made by the special study committee are outlined, and recommendations of the Seismic Safety Advisory Council for changes in school building procedures are presented.

SECTION 2

CURRENT SCHOOL BUILDING PROCEDURES

As a point of departure for discussing current practices in school building design and review, excerpts from the <u>Utah</u> <u>Code</u> (UCA) are cited that set forth State laws governing procedures for school design and construction and establishing responsibilities for administration of these laws among various entities of the State. In particular, portions of Chapter 11, "Building Schoolhouses," of the Utah Code are pertinent.

Section 53-11-2, UCA, prescribes that the State Superintendent of Public Instruction shall approve all school building plans for all school districts in Utah, except for cities of the first class (only the Salt Lake City School District is excepted by this language), when project costs exceed \$20,000. Section 53-11-2 further states that the approval of the Superintendent of Public Instruction shall be based upon compliance with standard building codes adopted by the State Board of Education and the State Building Board.

The State Building Board, by formal action in the fall of 1979, adopted the 1979 edition of the <u>Uniform Building Code</u>, including the earthquake design provisions contained in that code, and simultaneously adopted an amendment to the <u>Uniform Building Code</u> which substitutes a seismic zone map prepared by the Utah Seismic Safety Advisory Council for the UBC seismic zone map. Thus, there is in effect in the State of Utah a building standard which governs the design of school facilities.

Section 53-11-3, UCA, requires that the State Board of Education shall "adopt codes to govern the preparation of plans and specifications for school buildings in all school districts, except those of cities of the first class. Such codes shall include minimum standards for construction, heating, ventilation, sanitation, lighting, plumbing, structural safety, protection from fire, panic, and other dangers, and promoting the safety, health and comfort of the occupants...." The State Office of Education looks to the State Fire Marshall and the State Building Board for assistance in carrying out this legislated charge. For this report, it has not been established whether or not this responsibility has been delegated to these two agencies through formal action by the State Board of Education. Note is made, however, that the statutory provisions of Section 53-11, UCA, authorize the State Superintendent of Public Instruction to engage the services of other experts in this regard. Section 53-11-3 thus provides a statutory basis for earthquake safety in school building construction.

Section 53-11-4, UCA, states simply that the State Superintendent of Public Instruction is charged with the enforcement of the above provisions, and that he may employ the services of qualified personnel or may contract with the State Building Board for services to examine plans and specifications of proposed new school facilities.

Given the above information, we next examine those procedures currently

in effect by which the State Office of Education meets its statutory responsibilities. It has been determined that personnel of the Office of Education review plans and specifications for new school building construction from an educational program perspective but do not review them in terms of compliance with construction standards or codes that have been adopted. Certain of the code requirements are reviewed by other State agencies in accordance with agreements with the State Office of Education or as required by other regulations, but not all are reviewed for all school buildings.

Approval of the State Fire Marshall's Office is required by the Office of Education concerning the fire safety of a proposed school building. The State Building Board provides two types of reviews of plans and specifications for the State Office of Education. The first type of review is for schools for which State funds are used in construction. This type of review is the most comprehensive of the two types, and compliance with construction codes is included in the reviews. However, the State Building Board does not employ structural engineers, and so only a cursory structural review of plans is provided. The State Building Board has adopted the practice of requiring that structural calculations be submitted along with plans and specifications to be reviewed and approved. These calculations, as a very minimum, can be checked to ascertain that earthquake design has been considered for the project and so provide at least some assurance that earthquake safety has not been neglected. Still, suitability of the earthquake-resistance concepts and accuracy are not aspects of this review process. The second type of review performed by the State Building Board is for school facilities in which no State funds are used in construction. In this type of review, the State Building Board examines only those portions of plans and specifications that pertain to the handicapped and energy codes. No reviews of general construction or structural safety are made in this case.

From the above paragraph one may conclude that plans and specifications for proposed school facilities in which no State funds are used for construction are not subject to scrutiny by any State agency as regards their earthquake safety.

One next might ask whether or not the proposed school building plans and specifications are reviewed by any other agency or by anyone else along the line, such as by local building departments as occurs for most construction of other buildings before a building permit is issued. A limited survey of local building departments in Salt Lake Valley revealed that local school districts typically do not submit plans to local building departments and typically do not obtain building permits. No evidence can be found in Utah law that would require local school districts to do so, and they apparently do not.

There are other parties involved in the design and construction of school facilities where one might find assurance that expected construction standards have been met. These parties, all in the private sector, include the architects and engineers (the designers) and contractors (the builders). Contractors cannot be expected to serve in a review role and are not likely to raise questions about design details except in the most obvious cases of error. Yet, contractors can be expected to build in accordance with approved plans and specifications, and they should be held so accountable. Design professionals (architects and engineers) are licensed by the State of Utah after they have demonstrated competency in their disciplines. These design professionals are accountable for the competency of their work through State licensing, through ethical standards of their professions, and through legal constraints associated with possible future liability. These ethical and legal constraints normally seem to operate favorably to insure that safe buildings are constructed. However, total reliance upon these constraints alone fails to protect against the occasional error that a second review opinion might reveal or against the occasional unethical practitioner. Such problems do occur sometimes, although information on the frequency of occurrence is not available.

The above account of school building procedures currently followed in Utah suggests two possible ways in which substandard schools might be constructed unintentionally in Utah. First, there is the possibility of design error or unethical practice by design professionals. If either problem occurs, a school building may be constructed before it is noticed, and perhaps the problem may never be discovered. Second, plan review procedures followed in the State by governmental agencies are not structured and do not pretend to provide a comprehensive check on code compliance. Thus, the review procedures cannot be relied upon to provide that second opinion before a school is built.

SECTION 3

A SCHOOL BUILDING

WITH DESIGN DEFICIENCIES FOR EARTHQUAKE SAFETY

In the winter of 1980-1981, the Seismic Safety Advisory Council undertook investigation of a proposed new school facility which, after initial review, did not seem to meet current standards for earthquake safety adopted by the State. At the time this investigation was commenced, school plans had been submitted to and approved by the State Office of Education as well as by other reviewing agencies of the State. This school facility was of special interest to the Advisory Council, not just because a possibly unsafe school might be under construction, but more so as an example of the more general problem of ineffective school building review procedures. The Seismic Safety Advisory Council's investigation of the school, then was directed primarily to analysis of current school building procedures and to those factors which make it possible for unsafe schools (here, unsafe is used in the context of earthquake safety) to be built.

The school facility in question was a major auditorium addition to the Emery County High School located in Castle Dale, Utah, a seismic zone classified as U-2 by the Seismic Safety Advisory Council and as zone 2 by the Uniform Building Code (earthquake risk is identical in this case for the two zones).

A special committee formed by the Advisory Council, comprising representation from the architecture and structural engineering professions as well as from the State Office of Education and the State Building Board, studied plans for the proposed school addition and reached the conclusion that the plans were not in compliance with applicable codes. Indeed, provisional conclusions reached by the study committee were that the proposed facility had serious structural deficiencies that went beyond earthquake safety aspects. As well; the plans were deemed to be highly irregular in the method of structural representation, and outside of normal practices followed by the design professions. The general findings were that structural details were missing that would be essential for code-compliant construction, that some structural components were improperly sized, and that specifications called for much of the structural design to be done by means of shop drawings prepared by suppliers during construction.

As a consequence of these findings, personnel of the Emery County School District were briefed on the Advisory Council's investigation so that notification was made regarding deficiencies for that specific project. The study committee then evaluated various aspects of the school building process in an effort to discover not only how this situation could occur but also to discover possible improvements in procedures that would make such future problems less likely.

Occurrence of the school building problem described above likely is a result of several procedural deficiencies rather than attributable to any single factor. The deficiencies in procedures appear to fall into two

general categories: (1) the competency and accountability of design professionals, and (2) the adequacy of plan reviews by State agencies if that is to be the means of regulating school construction.

Evidently, both means currently are relied upon as a means for assuring that safe school buildings are constructed. But, as the Emery County High School addition implies, they are not fail-safe, either singly or in combination.

In the next section of this report, alternative procedures and modifications to current procedures are discussed which might provide greater assurance that substandard school buildings are not built in the future. Also, preferred solutions to the problem, as expressed by the study committee, are identified. Finally, recommendations by the Seismic Safety Advisory Council are presented.

SECTION 4

RECOMMENDATIONS FOR MODIFICATION OF SCHOOL BUILDING PROCEDURES

TO REDUCE EARTHQUAKE RISK

Ten alternatives were considered as possible changes in school building procedures in Utah. The list of alternatives, presented below, is not represented as being comprehensive of all possibilities, nor, as will be found in later discussions, is one alternative mutually exclusive of another.

Alternative 1:

Current statutory authorities granted to the State Office of Education and the State Building Board, and current licensing laws for architects and engineers may be adequate as they stand but simply require more aggressive application and enforcement by appropriate agencies of the State.

Alternative 2:

In the areas of professional practice by architects and engineers, current laws and regulations may need to be strengthened to give added assurance that design professionals engaged in school building planning meet code requirements. More severe and certain penalties may be needed when occurrences of incompetent practice are found.

Alternative 3:

To achieve more effective application of its school building review authority, as provided by law, the State Office of Education might employ qualified professional(s) to carry out more thorough reviews of plans and to check for compliance with applicable codes.

Alternative 4:

To strengthen its capability to provide comprehensive plan review services for school buildings, the State Building Board might employ personnel trained in structural engineering. As well, the State Building might undertake to clarify its role and expectations regarding review and approval of school building plans. (Misconceptions in this role and the extent of plan review have been observed more often than occasionally.)

Alternative 5:

Architecture and engineering design professionals might undertake, on their own through agreements within their professional organizations, to establish standards intended to strengthen professional services, such as through a peer review process by which other equally qualified professionals are invited to evaluate the plans for school buildings prepared by their colleagues. Such a peer review process would need to be organized formally rather than done merely as an ad hoc exercise in order to be effective.

Alternative 6:

A variation of Alternative 5 yet still a peer review process, the governmental reviewing agency might retain a consulting structural engineer other than the original design engineer to review the plans and specifications, selecting the review consulting engineer on a rotating basis from a list of qualified structural engineering firms. See Appendix E of this report for additional information about this alternative.

Alternative 7:

As a substitute for further State-level involvement in the process of school building plan review, local school districts might be given the option of retaining an independent reviewer of plans to insure their compliance with codes. Such a procedure necessarily would need to take into consideration the fee for professional review and the source of that fee.

Alternative 8:

The State of Utah might establish a specific agency or unit of an existing agency to review school building plans for code compliance and make approval of plans by such an agency a requirement to be met before authorizing construction to proceed. Such an organization, possibly within the State Office of Education or within the State Building Board, would provide greater insurance against substandard school building plans (here defined as non-compliance with earthquake safety codes), but at a cost of more governmental regulation of the process.

Alternative 9:

The State, acting through licensing boards, might act more aggressively to prosecute responsible parties for failure to comply with current laws and regulations (codes), leaving those current laws and regulations unchanged from what is the case today. Such increased prosecution would require that the investigative offices of the Department of Registration and the Department of Contractors be expanded to handle the increased work load.

Alternative 10:

As a means to insure that full structural engineering services are provided for every school building design, a regulation might be established requiring that a specified proportion of the fee for design services be allocated for engineering. This particular suggestion deals only with one aspect of the problem cited in Section 3--specifically, the possibility that substandard school buildings result from inadequate engineering services which, in turn, results from insufficient fees to buy the necessary engineering services.

It is to be noted that each of the alternatives outlined briefly above assume that current school building procedures are not effective and that changes are needed, either in form or in management. The possibility was examined by the special study committee that the substandard design of the Emery County High School addition was a unique case not repeated in other school buildings. Although opinions on this possibility were plentiful, the disconcerting conclusion reached is that no one really knows, and there is no means to answer the question without complete reanalysis of each recently completed school building. In other words, knowledge of whether or not earth-quake resistance was included in the design of school buildings completed in past years rests with the designers, and there is no documentation in the public record about this.

As an overview, preferences of the special study committee for modification of school building procedures were for adjustments in current procedures rather than for major revamping of the process. In general, committee members preferred not to pursue changes which would increase governmental involvement in regulating school construction through more intensive reviews of plans. No matter how valid the need might be for greater assurance that proposed school building plans meet current earthquake safety codes, there is an overriding fear that increased review in this case would lead to increased regulation and red tape in other construction matters. Yet, even with this significant reservation, the study committee agreed that current review procedures should be strengthened. There also was agreement in principle, though not in form, that licensing boards of the State must become more agressive in holding design professionals more accountable for the quality of service.

RECOMMENDATIONS FOR MODIFICATION OF STATE SCHOOL BUILDING PROCEDURES

After consideration of the issues presented in previous sections of this report, and also after consideration of the views and preferences of the special study committee that was formed to give advice on these issues, the Seismic Safety Advisory Council concludes that present procedures followed in the design and construction of school buildings in the State do not contribute to the goal of building earthquake-resistant structures, and that, unless changes in procedures are made, substandard school buildings may be constructed in the future. The phrase "may be constructed in the future" is used here to express the uncertainty of results if current procedures are continued.

As a consequence of these conclusions, and to provide remedies for this uncertainty, the Seismic Safety Advisory Council makes the following recommendations for modification of State school building procedures.

1. It is recommended that design documents for all school buildings proposed to be constructed in Utah contain separate structural plans and details, and that all such plans submitted for review by the State Office of Education or its delegated review agencies include structural calculations as a means to verify that earthquake resistance has been considered. Such documents should be retained by an agency of the State and available for future reference.

This recommendation does not alter current procedures in form but provides a means for determining, as a minimum, that

earthquake safety has been considered in the design of each school building. Although the Advisory Council recognizes that, within current review procedures, structural calculations may not be checked, the fact that such calculations have been prepared for the building serves to give added assurance that earthquake resistance has not been overlooked or ignored. The fact that calculations may not be checked by reviewers is not so much a concern as is the possibility present today that complete earthquake analysis is not even done.

2. It is recommended that State licensing boards strengthen procedures of accountability for proper and competent conduct of licensees, that steps be taken to simplify procedures under which licensee performance may be reviewed, and that complaints or other evidence of improper practices be promptly and agressively investigated.

During the course of its investigation of building practices in Utah, the Seismic Safety Advisory Council has heard expressions of dissatisfaction with unexpected frequency concerning the ability of licensing boards to deal effectively with instances of alleged improper conduct of persons licensed by the boards. Various reasons have been heard for this situation, such as legal constraints of due process to which everyone is entitled, lack of resources to carry out investigations and to pursue prosecutions, and complicated procedures for receiving complaints. As judged from the discussions about these various factors, probably all have at least some bearing upon effective administration of licensing laws. This recommendation deliberately is phrased in general terms to allow flexibility in correcting deficiencies believed to be present, yet the recommendation also is intended to emphasize that current processes by which licensee accountability is maintained requires reevaluation.

3. It is recommended that the State Office of Education act more forcefully to assert its statutory authority and responsibility for approval of new school building plans and specifications, giving increased emphasis to school building safety and its expectation that applicable adopted codes and standards must be met.

This recommendation respects a prevalent view that increased governmental regulation of school building construction is undesirable and should be done only after other possible actions to strengthen school building practices have proven to be unworkable. Thus, this recommendation calls for no new reviews of plans, yet would give emphasis to the purposes of procedures presently in place. The Advisory Council notes, however, that the effectiveness of this recommendation in assuring that code-compliant schools are designed and built is highly dependent upon the diligence of the approving State agencies. In this regard, the Office of Education has the primary responsibility to include all safety aspects of buildings in the reviews undertaken. 4. It is recommended that the scope and nature of structural engineering services for proposed school building projects be identified as a part of agreements for professional design services by local school districts, and that contract agreements for design services prescribe, or at least identify, the extent of expected structural engineering services.

Based upon findings from review of school building procedures in Utah, the Seismic Safety Advisory Council has concluded that incomplete or inadequate structural engineering which fails to achieve earthquake safety in the design of school buildings results, at least in part, from absence of clear understandings and agreements as to what constitutes a complete and proper service. School districts apparently assume, either correctly or incorrectly, that agreements entered into for design services implicitly provide for complete and proper services, but may not know completely what is entailed in that complete service. Consequently, the school districts are at a disadvantage to know whether and how code compliance with earthquake safety provisions has been accomplished. It is the Advisory Council's view that this matter should not be left to chance, as apparently now most often is the case. In the case of school building safety, and to the extent that building safety may be jeopordized as a result of incomplete or inadequate engineering, the design professions must be called upon to disclose the scope of their services and must be constrained from providing limited services as a result of efforts to contain costs.

5. It is recommended that a program be commenced by the State of Utah to review earthquake safety of school buildings constructed since 1970 in the State for the purpose of discovering the extent and nature of any absence of structural capability to withstand earthquake forces as prescribed by provisions of codes applicable at the time of construction of the buildings.

The Seismic Safety Advisory Council is alarmed with findings resulting from investigation of the Emery County High School addition as well as with the lack of information by which the possibility of similar problems may be evaluated for other school buildings recently constructed in the State. The possibility that there may be other school buildings in place that are not in compliance with earthquake safety codes and that are of recent construction is viewed as a serious matter. It is in the best interest of Utah citizens that this recommendation be implemented.



STATE OF UTAH DEPARTMENT OF NATURAL RESOURCES

SEISMIC SAFETY ADVISORY COUNCIL

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APPENDIX A

SCOTT M. MATHESON Governor DELBERT B. WARD Executive Director

COMMITTEE REPRESENTATIVES

SPECIAL STUDY COMMITTEE ON SCHOOL BUILDING PROCEDURES

A COMMITTEE OF THE UTAH SEISMIC SAFETY ADVISORY COUNCIL

ORGANIZATION

Seismic Safety Advisory Council

American Institute of Architects

Structural Engineers Association of Utah

Utah Office of Education

Utah State Building Board

REPRESENTATIVE

Winfred O. Carter Delbert B. Ward (Staff Support)

Edward F. Smith

Ronald Weber Parry Brown (Alternate) Leon Tanner (Alternate)

Scott Bean

Nathan Woolley Einar H. Johnson (Alternate)



STATE OF UTAH DEPARTMENT OF NATURAL RESOURCES

SEISMIC SAFETY ADVISORY COUNCIL

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APPENDIX B

DELBERT B. WARD Executive Director

SCOTT M. MATHESON Governor

> COMMITTEE CHARGE SPECIAL STUDY COMMITTEE ON SCHOOL BUILDING PROCEDURES

> > Convened By Utah Seismic Safety Advisory Council March 6, 1981

The 1977 Utah Legislature created the Seismic Safety Advisory Council for the purposes of assessing earthquake risk in the State of Utah and recommending State policies for improved earthquake safety. The Advisory Council has noted that earthquake hazards reduction involves both preearthquake mitigation practices and post-earthquake response and recovery. The Advisory Council has further noted that improved mitigation practices will produce the most cost-effective earthquake safety program for the State of Utah and also is the aspect which is in the greatest need of improvement.

Studies of Utah school facilities during the past four years indicate that earthquake safety deficiencies are present. The presence of these deficiencies have raised questions among members of the Advisory Council regarding procedures by which school facilities are designed, reviewed, and constructed, because earthquake safety deficiencies continue to occur even though some people believe the procedures adequately safeguard against this possibility.

The Special Study Committee on School Building Procedures has been convened to evaluate current procedures for building schools in Utah and to furnish information to the Seismic Safety Advisory Council concerning the adequacy of those procedures. In particular, the Special Study Committee on School Building Procedures is asked to:

- Review current procedures by which school buildings are designed, reviewed, and constructed in the State of Utah.
- Evaluate the adequacy of current procedures as to their effectiveness in ensuring that school facilities so constructed have appropriate resistance to earthquake effects.
- Identify deficiencies, if any, that may exist in current procedures which do or could result in improper or inadequate earthquake resistance in school facilities.

 Suggest remedies in procedures and practices to correct observed deficiencies.

The work of this Special Study Committee is intended for use by the Seismic Safety Advisory Council for consideration in establishing appropriate earthquake safety policy recommendations dealing with school buildings.



STATE OF UTAH DEPARTMENT OF NATURAL RESOURCES SEISMIC SAFETY ADVISORY COUNCIL

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APPENDIX C

SCOTT M. MATHESON Governor DELBERT B. WARD Executive Director

MINUTES

SPECIAL STUDY COMMITTEE ON SCHOOL BUILDING PROCEDURES

A Committee Of The

Utah Seismic Safety Advisory Council

March 6, 1981

TIME: : 3:00 p.m. to 5:00 p.m.

- PLACE: Regents Conference Room (Second Floor) 807 East South Temple Salt Lake City, Utah 84102
- PRESENT: Parry Brown (Structural Engineers Association of Utah) Winfred O.Carter (Utah Seismic Safety Advisory Council) Einar H. Johnson, Jr. (Utah State Building Board) Pauline Keppen (for Scott Bean, Utah Office of Education) Edward F. Smith (American Institute of Architects) Delbert B. Ward (Utah Seismic Safety Advisory Council) Nathan Woolley (Utah State Building Board)

COMMITTEE CHARGE AND PURPOSE

The first meeting of this special study committee was called to order by Del Ward, Executive Director of the Utah Seismic Safety Advisory Council. He explained that the committee was established to provide expert counsel regarding the adequacy of current procedures followed in the design and construction of new school facilities to ensure that earthquake safety is properly considered as a safeguard to life, health, and property. The committee was established by the Utah Seismic Safety Advisory Council, and the findings resulting from the work of the committee are intended primarily for use by the Advisorv Council in development of earthquake safety policy recommendations for the State of Utah. D. Ward further explained that the committee comprises representatives of governmental and private organizations having major involvement in the school building process--namely, the State Office of Education, the State Building Board, the American Institute of Architects, and the Structural Engineers Association of Utah.

D. Ward noted that the Seismic Safety Advisory Council has studied earthquake risk to Utah school buildings during the past several years, as a part of its legislative charge to recommend State policies for earthquake hazards reduction, and that possible deficiencies have been observed in the process by which school buildings are designed and constructed and which may result, in some instances, in inadequate earthquake resistance for the buildings. The expert study committee is asked to review current procedures by which school buildings get built in Utah, giving particular attention to the suitability of these procedures for ensuring that the resulting structures are resistive to earthquakes expected in the Utah seismic environment. The committee of experts, who have first-hand knowledge of current school building procedures and also are familiar with current standards of performance of the building industry, are asked to provide an objective analysis of these current procedures and to assess the adequacy of the procedures from the point of view of earthquake safety, either confirming or rejecting the Seismic Safety Advisory Council's contention that there are deficiencies in the current procedures.

The Seismic Safety Advisory Council will utilize the findings of this expert study committee in developing earthquake safety policy recommendations for new school facilities.

D. Ward provided to committee members a written statment of the charge (see Attachment) which sets forth the specific goals that the Advisory Council hopes will be accomplished.

D. Ward further noted that his role with the committee will be in an administrative and staff capacity. His responsibility, he explained, will be to articulate the findings of the study committee for use by the Seismic Safety Advisory Council, and to assist the committee in meeting its charge.

E. Smith, AIA representative, expressed a preliminary view that current procedures may be quite adequate to ensure earthquake safety in school facilities. He based this view on two observations. First, architects and engineers have a legal and ethical responsibility to prepare their designs in compliance with currents codes and standards and, in their professional judgement, in accord with sound building practices. He stated that he is not aware that these responsibilities are not being met by design professionals in Utah. Second, he noted that current procedures for school facility design and construction now require certain reviews and approvals by State agencies. He suggested that these reviews may be adequate for the purpose of ensuring earthquake safety, and he further indicated concern about the need for any more governmental reviews besides those already in effect.

D. Ward responded to E. Smith's comments by noting, first, that an example of a school facility will be presented to the committee for analysis which raises questions regarding its ability to resist earthquake forces; yet it was designed by architects and engineers and was subjected to all the required review and approval procedures. He noted, second, that review procedures for school facilities may be different in actual practice than in written form or in individual perception, and he indicated that he will present to the committee for confirmation and evaluation the actual practices in Utah by which school facilities get built. These practices may be different than you believe, he advised the committee.

CURRENT PRACTICES IN SCHOOL BUILDING DESIGN AND REVIEW

As a point of departure for discussing current practices in school building design and review, D. Ward presented to the committee excerpts from the <u>Utah Code</u> that set forth State laws governing procedures for school design and construction and establishing responsibilities for administration of these laws among various entities of the State. In particular, portions of Chapter 11, "Building Schoolhouses," of the <u>Utah</u> <u>Code</u> were furnished to committee members. D. Ward then pointed to specific requirements in Sections 53-11-2, 53-11-3, and 53-11-4 which establish basic procedures and authorities.

Section 53-11-2 prescribes that the State Superintendent of Public Instruction shall approve all school building plans for all school districts in Utah, except for cities of the first class (only the Salt Lake City School District is excepted by this language), when project costs exceed \$20,000. Section 53-11-2 further states that the approval of the Superintendent shall be based upon compliance with standard building codes adopted by the State Board of Education and the State Building Board.

The State Building Board adopted by formal action in the fall of 1979 the 1979 edition of the <u>Uniform Building Code</u>, including its earthquake design provisions, and simultaneously adopted an amendment to the Code which substitutes a seismic zone map prepared by the Utah Seismic Safety Advisory Council for the UBC seismic zone map. Thus, there is in effect in the State of Utah a building standard which governs the design of school facilities.

Section 53-11-3 requires that the State Board of Education shall "adopt codes to govern the preparation of plans and specifications for school buildings in all school districts, except those of cities of the first class. Such codes shall include minimum standards for construction, heating, ventilation, sanitation, lighting, plumbing, structural safety, protection from fire, panic and other dangers, and promoting the safety, health and comfort of the occupants... " The State Office of Education looks to the State Fire Marshall and the State Building Board for assistance in carrying out this legislative charge. It has not been established whether or not this responsibility has been delegated to these two agencies through formal action by the State Board of Education. Section 53-11-3 thus provides a statutory basis for earthquake safety in school construction.

Section 53-11-4 states simply that the State Superintendent of Public Instruction is charged with the enforcement of the above provisions, and that he may employ the services of qualified personnel or may contract with the State Building Board for services to examine plans and specifications of proposed new school facilities.

With the above information, committee members sought next to clarify those procedures currently in effect by which the State Office of Education meets its statutory responsibilities. It was concluded (although not directly confirmed by the Office of Education) that personnel of the Office of Education review plans and specifications from an educational program perspective but do not review them in terms of compliance with construction standards of adopted codes.

Approval of the State Fire Marshall's Office is required by the Office of Education concerning the fire safety of a proposed school building. The State Building Board provides two types of reviews of plans and specifications for the State Office of Education. The first type of review is for schools for which State funds are used for construction. This type of review is the most comprehensive of the two types, and compliance with construction codes is included in the reviews. However, the State Building Board does not employ structural engineers, and so only a cursory structural review of plans is provided. The State Building Board has adopted the practice of requiring that structural calculations be submitted along with plans and specifications for buildings to be reviewed. These calculations can be reviewed to ascertain that the earthquake design has been considered and so, as a minimum, provides assurance that earthquake safety has not been neglected. The second type of review performed by the State Building Board is for school facilities in which no State funds are used in construction. In this type of review, the State Building Board examines only compliance with standards for the handicapped and the energy code. No reviews of general construction or structural safety are made in this case.

From the above paragraph, one may conclude that plans and specifications for proposed school facilities in which no State funds are used for construction are not subject to scrutiny by any State agency as regards their earthquake safety.

One next might ask whether or not the proposed school building plans and specifications are reviewed by any other agency or by anyone else along the line, such as by local building departments before construction commences, as occurs for most new construction and as normally is required before a building permit is issued. A limited survey of local building departments in Salt Lake Valley reveals that local school districts typically do not submit plans to local building departments and typically do not obtain building permits. No evidence can be found in the law that would require local school districts to do so, and they apparently do not.

There are some other parties involved in the construction of school facilities where one might find assurance that expected construction standards have been met. These parties, all in the private sector, include the architect/engineer (designers) and contractors. Contractors cannot be expected to serve in a review capacity and are not likely to raise questions about design details except in the most obvious cases of error. The building design professionals are held accountable for their work through State licensing, through ethical standards of the professions, and through the legal constraint of possible future liability. These legal and ethical constraints normally seem to operate favorably to ensure that safe buildings are constructed. However, complete reliance upon these constraints alone fails to protect against the occasional error that a second review might catch or against the occasional unethical practitioner. Such problems do occur sometimes, although information is not available on their frequency. In the case of schools housing children who are not always resourceful in times of crisis, perhaps even a single occurrence of design error or unethical professional conduct is excessive if life safety is placed at risk.

REVIEW OF A SPECIFIC SCHOOL BUILDING DESIGN

D. Ward presented to the committee the plans of a recently designed high school addition which, he stated, had come to his attention because there seemed to be deficiencies in the structural design documents. D. Ward noted that he was seeking the opinion of the expert committee as to whether or not the structural design actually is deficient as regards earthquake safety. If it is found to be deficient, he said, then the building would be an example of possible other deficiencies in the process by which school buildings get built, for the deficiencies of design were not discovered through the routine process followed when the building was approved for construction.

The particular school building plans presented to the committee have run the course of State review procedures cited earlier. The plans were prepared by licensed architects and engineers. The plans were submitted to the State Office of Education, and from there they were sent to the State Fire Marshall and the State Building Board for review. Since the building required no State funds for construction, review by the State Building Board was limited to a check for compliance with the handicapped and energy codes. The plans subsequently were approved by the State Superintendent of Public Instruction, and construction has been authorized. The question to be answered by the study committee, said D. Ward, is: "Is the building capable of resisting earthquake lateral forces as designed?"

The remainder of this first meeting of the expert study committee on school building procedures was given to scrutiny of the example plans. Committee members expressed uncertainty about the building's earthquake resistance, due to its complexity that precluded quick judgements, but they acknowledged that certain information contained in the drawings was irregular and not consistent with prevailing standards of current practice.

FOLLOW-UP ACTION BY THE STUDY COMMITTEE

The committee concluded that further analysis of the school building plans would be necessary before the question of earthquake safety adequacy could be answered. Two issues are to be studied. The first, a more rigorous analysis of selected structural systems of the building, is to be undertaken by Parry Brown (Structural Engineers Association of Utah). The second, a gathering of additional information concerning agreements for professional services between the local school district and the architects/engineers, is to be done by D. Ward. The findings pertaining to these two issues will be reported back to the study committee at the next meeting. In addition, it was agreed by all present that effort should be made to identify other example school projects that might have similar safety deficiencies and that might have resulted from inadequate review procedures. D. Ward accepted this responsibility and will seek other possible examples.

ADJOURNMENT

The committee meeting was adjourned at 5:10 p.m.



STATE OF UTAH DEPARTMENT OF NATURAL RESOURCES SEISMIC SAFETY ADVISORY COUNCIL

807 EAST SOUTH TEMPLE . SUITE 103 . SALT LAKE CITY, UTAH 84102

APPENDIX D

SCOTT M. MATHESON Governor DELBERT B WARD Executive Director

MINUTES

SPECIAL STUDY COMMITTEE ON SCHOOL BUILDING PROCEDURES

A Committee Of The

Utah Seismic Safety Advisory Council

May 6, 1981

TIME: 3:00 p.m. to 4:45 p.m.

PLACE: Regents Conference Room (Second Floor) 807 East South Temple Salt Lake City, Utah 84102

PRESENT: Committee Members:

Parry Brown (SEAU) Winfred O. Carter (SSAC) Scott Bean (Office of Education) Edward F. Smith (AIA) Richard Tholen (Building Board) Ronald H. Weber (SEAU)

Staff:

Delbert B. Ward (SSAC)

Others:

Rue Ware (Emery County School District)

AGENDA

This second meeting of the Special Study Committee on School Building Procedures was convened for the purpose of (1) Hearing a report from the structural engineers represented on the committee concerning the structural adequacy of additions to the Emery County High School regarding earthquake safety design considerations, and (2) Discussion of building procedures for new schools given the findings from review of the additions to Emery County High School.

D. Ward called the meeting to order and explained that the preliminary structural engineering evaluation of the Emery County High School had been completed by the engineer members of the study committee, but that the findin 3 were unknown to himself. The results, he said, would indicate whether the committee should evaluate the procedures described at the last meeting, or, if no deficiencies were found, to conclude the investigation.

D. Ward also introduced Rue Ware, Building Director for the Emery County School District. Mr. Ware was invited to the meeting to hear the results of the engineering evaluation after it was determined that the School District, on its own, had commenced a similar investigation. D. Ward explained that, upon learning of the Emery County School District's concern about the new building, he had contacted Mr. Ware and briefed him on the investigation undertaken by the Seismic Safety Advisory Council. Mr. Ware was aware, he said, that the study committee's findings would be preliminary and incomplete, and could not be the basis for specific action by the School District. Nonetheless, the findings would be helpful to the District inasmuch as the presence of structural deficiencies would or would not be identified, and the District would have sufficient information for deciding whether or not to pursue their own investigation further.

STRUCTURAL ENGINEERING REPORT ON ADDITIONS TO THE EMERY COUNTY HIGH SCHOOL

R. Weber presented the findings resulting from work by three structural engineers who reviewed plans for the additions to Emery County High School. The three engineers, R. Weber, P. Brown, and L. Tanner, were designated to serve on the special study committee by the Structural Engineers Association of Utah.

R. Weber reported that the committee had concluded that the new building has serious deficiencies with respect to resistance to lateral forces, including those that might be caused by earthquake or wind. He noted that the reviewers had not attempted to evaluate the entire structural system of the building, but instead had focussed their attention on selected components suspected to be inadequate. Two such components were described. One, a column over 60 feet long attached to the auditorium, was determined to have a load-carrying capacity less than required for either wind forces or earthquake forces. A second inadequacy was found in the chording of diaphragms. He implied that the load path for transfer of lateral forces through the building had not been suitably resolved. In reply to a question from D. Ward, he stated that, in his opinion, the plans for the school are not in compliance with the current <u>Uniform Building Code</u>.

There was discussion about the preparation of construction documents, particularly the absence of separate structural drawings for the building. R. Weber commented that integration of architectural and structural drawings can be accomplished, in principle, in an acceptable manner, but that such a procedure is highly unusual for large projects, such as the Emery County High School. However, he also noted that there is an absence of structural details in the drawings for the high school which makes the integration incomplete in this case. Consequently, much of the detail for connections and other things important for achieving earthquake resistance must be achieved during the construction phase, either in shop drawings or by field personnel. Such a procedure carries a risk that connections and other details may not receive the necessary engineering checks. Moreover, such a procedure makes review of the plans extremely difficult. In some situations, there is no way to know that proper engineering will be accomplished. In this regard, the construction documents are viewed as deficient.

R. Ware was asked to comment upon fees paid for professional design services. The question was intended to obtain information as to whether or not the fees paid for services were too low to obtain a complete design service. R. Ware responded that the District paid a fee of 8 percent of construction cost and for this fee expected a complete professional design service. He noted that 8 percent is higher than normally is provided, but the higher fee was paid because the work entailed a substantial amount of remodelling as well as new construction. It was concluded that the fees paid were sufficient to obtain a complete design service.

Effort also was made to establish the distribution of fees among the project architect and structural engineer. R. Ware commented that his information is that the structural engineer was hired by the architect on an hourly basis and that there was no limit on the number of hours. It could not be determined from the information available whether or not the structural engineer actually was authorized by the architect to provide a complete engineering service.

IMPLICATIONS OF FINDINGS CONCERNING SCHOOL BUILDING PROCEDURES

Given the findings cited above, it is evident that seismically unsafe schools can be constructed in Utah today even though current review procedures are fully followed. The addition to Emery County High School illustrates this. Plans for the school were submitted to and approved by all agencies having jurisdiction, including the Office of Education, the State Building Board, and the State Fire Marshall's Office. In accordance with current procedures, the State Building Board reviewed the plans only for compliance with the energy code and the handicapped code. The State Fire Marshall's Office reviewed plans for compliance with fire safety codes. The plans were not reviewed for other provisions of the <u>Uniform Building Code</u>, and, also in accordance with current procedures, no reviews of structural safety were made. Compliance with these provisions of the applicable code was left to the architect and structural engineer of record for the project.

D. Ward suggested to the committee that the deficiencies of the Emery County High School project could be a result of any one or combination of the following.

(1) The architectural and structural engineering services are inadequate, leading to the possibility that architectural and engineering licensing laws should be strengthened to hold accountable those professionals who render inadequate services. (2) Plan review procedures which fail to include confirmation of compliance with applicable building codes are insufficient to ensure that safe buildings are constructed.

(3) There is in Utah a pervasive absence of awareness of earthquake safety and a consequent failure to consistently incorporate earthquake resistance into new school construction.

(4) There exists a widespread view that current procedures for building schools includes adequate safeguards and reviews to insure that earthquake safety has been considered when, in fact, it may not have been.

D. Ward urged the study committee to consider these possibilities plus any others that might be thought of, and to suggest changes in procedures that would correct the problems discovered. It was agreed that committee members would furnish their thoughts to D. Ward who will prepare a summary of possible remedies for consideration at the next meeting. He noted that the committee should seek to conclude its work within the next four to six weeks; since the Seismic Safety Advisory Council must have the recommendations by then in order to reach its own conclusions before June 30, 1981.

Members of the study committee discussed a variety of possible ways to improve school building procedures. The ideas ranged from increased reviews and approvals by some State agency to methods for greater accountability and improved performance by the design professions to new techniques within the private sector and governmental sector which would strengthen current proceedures. In general, the group appeared to favor some solution that will not increase plan review and checking by governmental agencies. Many good reasons were cited for avoiding more governmental review and approval-among them project delays, increased costs for design services, and general mistrust of bureaucrats. One alternative, suggested by R. Weber, would create a process of peer review, similar to the process of value engineering, in which professional peers would be convened to comment upon the plans prepared for a building. R. Weber noted that such a process has been started informally by the Structural Engineers Association of Utah and that it has been helpful to his group as a means to expose design weaknesses not intended.

ADJOURNMENT

The committee meeting was adjourned at 4:45 p.m.

APPENDIX E

PROCEDURAL FORMAT SUGGESTIONS FOR PLAN-CHECKING

AND QUALITY CONTROL OF BUILDINGS WITH REGARD TO

STRUCTURAL ENGINEERING

Obtaining a structurally safe, code-compliant building is essentially a five step process:

- 1. Structural engineering design by a licensed engineer.
- 2. Transfer of design concepts to contract drawings.
- 3. Review of plans, specifications and calculations by qualified building officials or their designates prior to issuing a permit.
- 4. Review of manufacturer's shop drawings for conceptual compliance with the contract drawings. This review is normally performed by the design engineer.
- 5. Periodic observations (and special inspection as required) of the structural system during construction for compliance with contract drawings. The periodic observation is normally performed by the design engineer.

The following steps are recommended as a minimum format for quality control of building design and construction with regard to <u>structural engineering</u>.

- Require Structural Engineer's stamp on drawings for all buildings larger than small residential-type buildings prior to issuing a building permit.
- 2. Require Structural Engineering calculations including a table of contents of the calculations prior to issuing a building permit.
- 3. Require <u>periodic</u> observation of the structural system during construction by a structural engineer. Require special inspections in accordance with U.B.C. Section 305 when appropriate.

A system of peer plan review is proposed as the preferred method for reviewing contract documents and calculations. Under this system, the building officials would retain a consulting structural engineer other than the original design engineer to review the contract documents and calculations. A list of qualified structural engineering firms could be obtained from the Structural Engineers Association of Utah. It is suggested that reviewing firms be selected on a rotating basis. This review may vary in scope but would include as a minimum:

- 1. A spot review of calculations to see that major design code considerations had been attended to, namely:
 - a. Gravity load analysis.
 - b. Wind and seismic lateral load analysis.
 - c. Combined loadings.
 - d. Special considerations such as crane loads, bracing, diaphragms, etc.
 - A review of drawings for general adequacy and to ascertain that design concepts inherently expressed in the structural calculations have been adequately conveyed in the contract drawings and specifications.

It is not intended that this structural review of contract drawings and calculations be comprehensive to the extent of checking arithmetic accuracy, but rather a check for general design concepts and code conformance in a general, rather than detailed sense. An experienced structural engineer would be able to perceive the general adequacy of the design calculations and drawings without a large expenditure of time. It is intended that this process be simple, direct and low in cost to the owner.

There are two specific aspects of peer plan review which are mutually reinforcing. The first is that an engineer, knowing that his plans and calculations will definitely be reviewed by one of his peers, will be less likely to produce work which does not measure up to the current state of the art standards. The second is that the long-term process of revolving peer plan review will serve to expedite the dissemination of the state of the art; that is, seeing how one's peers solve problems is an educational experience. Thus, a general upgrading of the profession is inherently built into the peer plan review system.

An obvious alternative to the peer plan review process is some governmental layer of plan review in which certain qualified professionals are employed directly by a government agency, such as the State Building Board or the State Office of Education.