NATIONAL BUREAU OF STANDARDS REPORT

10 575

Not for publication
or for reference

A METHODOLOGY FOR THE DEVELOPMENT OF REQUIREMENTS FOR THE PHYSICAL ELEMENTS OF A DWELLING

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
[2] Part of the Center for Radiation Research.
[3] Located at Boulder, Colorado 80302.

NATIONAL BUREAU OF STANDARDS REPORT

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A METHODOLOGY FOR THE DEVELOPMENT OF REQUIREMENTS FOR THE PHYSICAL ELEMENTS OF A DWELLING

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NATIONAL BUREAU OF STANDARDS

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A METHODOLOGY FOR THE DEVELOPMENT OF REQUIREMENTS FOR THE PHYSICAL ELEMENTS OF A DWELLING

THE HOUSING PROBLEM: QUANTITY

The major area of concern for the American consumer, relevant to the "housing problem," is the availability of housing at low or moderate cost.

On the assumption that the construction industry will be unable to supply the needed quantity of housing by using conventional building techniques, the Federal Government has fostered the development and growth of the factory-built housing industry. Operation BREAKTHROUGH is the Department of Housing and Urban Development's (HUD) program to establish mass produced, factory-built housing as an acceptable and reliable source of dwelling units to satisfy the ever increasing needs of the American public.

The concept of mass production is naturally conducive to the development of innovative techniques, materials and systems. The proprietary standards and specifications that have guided the construction of conventional housing in the past are no longer adequate for the evaluation of the new and varied housing systems proposed under the Operation BREAKTHROUGH program.

The Operation BREAKTHROUGH Guide Criteria is a four volume performance specification which sets the levels of performance for the various built elements of a dwelling. By establishing Requirements, Criteria and Tests, the Guide Criteria provides a standard by which any innovative or conventional housing system can be evaluated on the basis of its performance rather than its adherance to conventional practice.

THE HOUSING PROBLEM: QUALITY

For the most part, American housing satisfies minimum requirements for health and life safety and provides moderately adequate facilities for the performance of traditional functions and activities. A dwelling, however, should be a safe, comfortable, satisfying environment that contributes positively to the physical and mental development and well-being of its occupants.

The Two-Year Housing Project represents a systematic approach to the analysis of user needs as they relate to the physical elements of a dwelling. Unlike the Guide Criteria, which is based on technological expertise and judgment, the Two-Year Project is committed to a performance descriptor for housing based on human needs, aspirations and abilities.

OBJECTIVE

One of the fundamental objectives of the Two-Year Housing Project, is to relate the properties derived from the physical elements of housing to the needs generated by the users of that housing.

Our efforts, thus far, have been directed toward obtaining and collating information concerning the surfaces with which the user comes in contact. The surfaces have been defined as interior walls, ceilings, floors, work surfaces, accessories and assemblies, and exterior walls, roofs, accessories and assemblies.

USER NEEDS

The user has certain psychological, physiological, and sociological needs which he attempts to satisfy, to some extent, by adjusting to or modifying his environment. He also generates physical, chemical and biological forces, during his activities, which act upon the surfaces of his environment, and which the surfaces, in turn, must react to or resist.

In order to make an optimum decision on which material choice will satisfy his needs, the user must first know:

a. The magnitude of his own needs in terms of health, safety, comfort, and lifetime serviceability;
b. The levels of performance, in those same categories, of the materials from among which he must make his choice.

MATERIALS TECHNOLOGY

The technologies of materials are often based on phenomena relating to failures or inadequacies of performance in use. Test methodologies are primarily material specific and are designed on the basis of cause and effect relationships. In order to establish some measure of reliability and durability, evaluative procedures often include predictive elements. The properties which are of concern to the materials technologist are, therefore, properties such as abrasion resistance, chalking resistance, corrosion resistance, fire retardancy, light fastness, and stain resistance.

The traditional approach to the development of materials testing and evaluation has created enclaves of methodologies and expertise that do not enhance analytical processes based on the performance concept. Specific problems are dealt with as they occur within a technology and over time the solutions become an historical aspect of that technology. As new materials are developed and marketed, they are labeled and assigned a technological category.

A systematic analysis of fundamental properties should be developed in order to establish evaluative procedures for materials based on use and exposure forces rather than on the basis of categorization and similarity to other materials.

It is important that the technology that measures the user's needs be compatible with the technology that measures the material's response or property so that clear-cut relationships in physical, chemical and mathematical terms can be developed.

THE METHODOLOGY

The following methodology has been developed in order to derive Requirements and identify criteria for the physical elements of a dwelling by means of a systematic process. The methodology is based on a simple concept, which is, that forces are generated by the user, the site and the climate; these forces cause effects; the effects are maximized or minimized by the intrinsic properties of materials or systems. The properties that control effects become, by definition, the requirements of the materials or systems.

This methodology establishes a systematic derivation of forces and effects that must be quantified in order to set criteria or levels of performance. It provides a series of checklists and relationships which can be regenerated on varying levels of complexity. Each parameter, matrix or list can be generalized, specialized or expanded to a higher level of detail on the basis of selected priorities or restrictions.

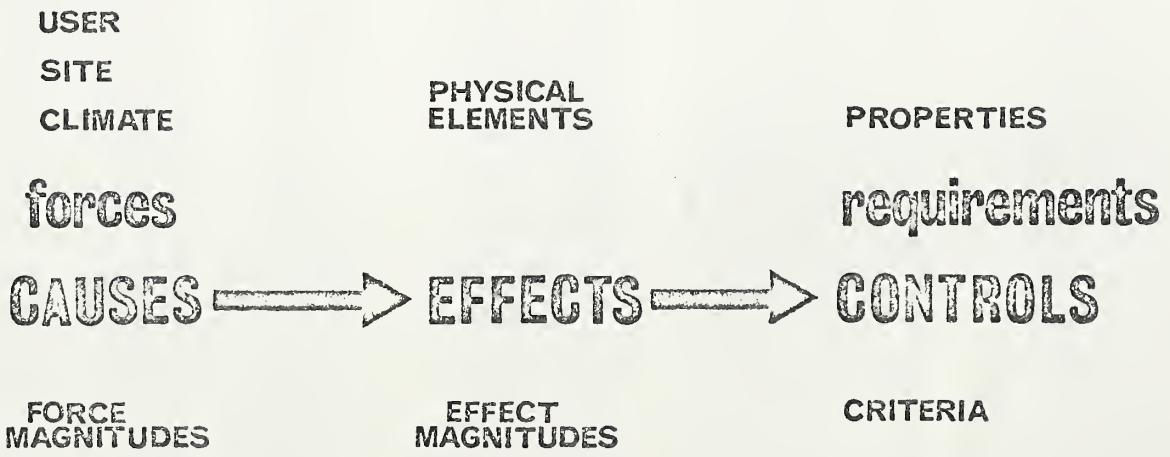
The methodology is applicable to the consideration of all physical elements, but only insofar as they are related to physical forces. The psychological, sociological and physiological aspects of life cannot be evaluated by this methodology without an intermediate force analysis of those aspects.

The immediate application of this methodology is its use in developing performance requirements for materials and systems based on primary and secondary properties described in Appendix A.

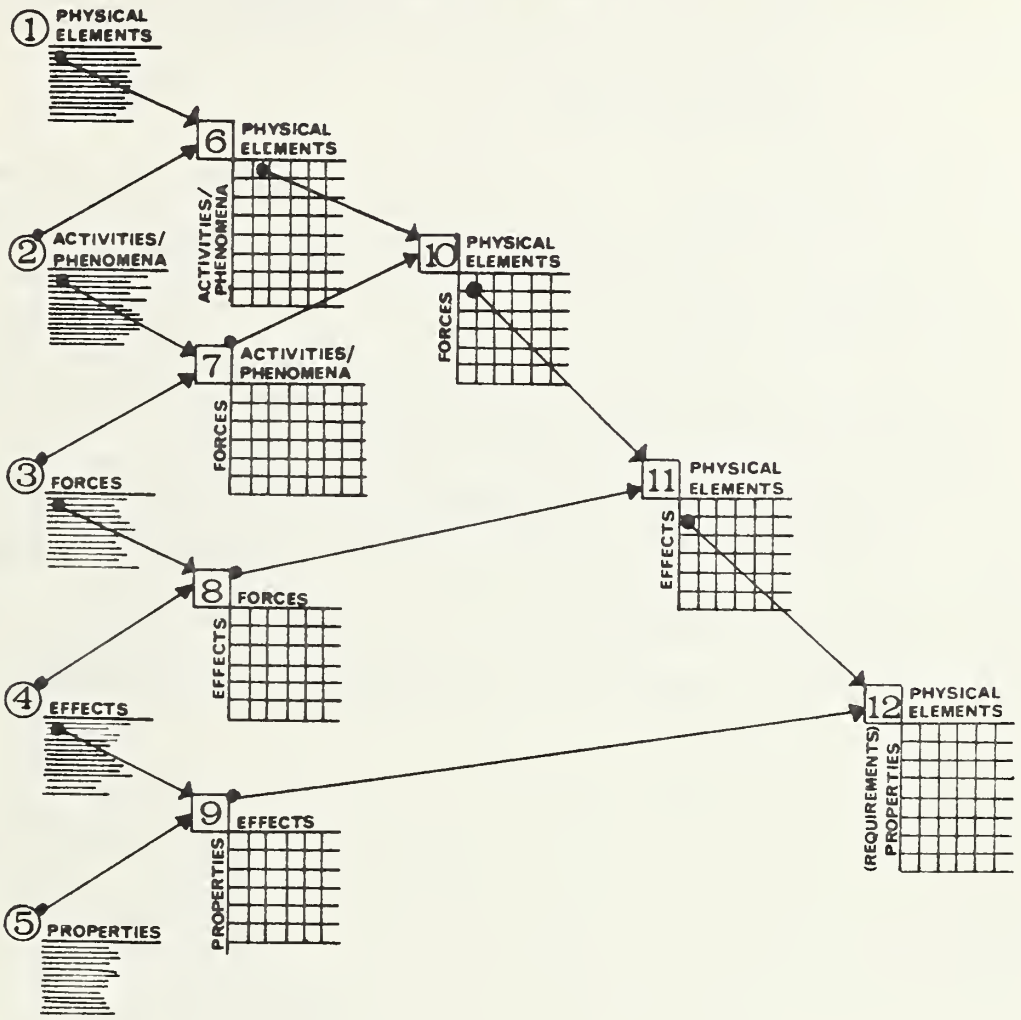
The long-range utility of this methodology lies in its applicability as a procedural aid in establishing Criteria, or levels of performance, for materials or systems.

A major input to this methodology, which is a necessary prerequisite for establishing balanced criteria, is the consideration of user needs. The behavioral aspects of life in a dwelling should be developed such that critical needs, desires and actions as they originate with the user are identified and prioritized. Those aspects that are translatable into forces and effects can be incorporated directly into the methodology. User needs that cannot be so translated may or may not be critical with reference to the Built Elements of the dwelling but will have to be evaluated by some other method of analysis.

methodology concept



A METHODOLOGY FOR DEVELOPING REQUIREMENTS FOR THE PHYSICAL ELEMENTS OF HOUSING



Lists ① and ⑤ are derived analytically from the given BUILDING.
The Activities in list ② are derived analytically from the given USER.
The Phenomena in list ② are derived analytically from the given CLIMATE and SITE.
Lists ③ and ④ are based on technological analysis and judgment.
Matrices [10] , [11] , and [12] are derived by the simultaneous analysis of the parent matrices each of which contains a common coordinate.

METHODOLOGY OUTLINE

1. List PHYSICAL ELEMENTS
2. List User ACTIVITIES, Site-Climate PHENOMENA
3. List FORCES (User, Site, Climate)
4. List EFFECTS
5. List PROPERTIES
6. Identify which PHYSICAL ELEMENTS are involved with which ACTIVITIES/PHENOMENA
7. Identify which FORCES are generated by which ACTIVITIES/PHENOMENA
8. Identify which EFFECTS result from which FORCES
9. Identify which PROPERTIES control which EFFECTS
10. Analyze which FORCES are involved with which PHYSICAL ELEMENTS
11. Analyze which EFFECTS occur to which PHYSICAL ELEMENTS
12. Analyze which PROPERTIES are REQUIREMENTS for which PHYSICAL ELEMENTS

1. List the PHYSICAL ELEMENTS of a Dwelling

The Physical Elements of a Dwelling have been defined in terms of four basic categories as follows:

STRUCTURE	TRANSPORT SYSTEMS
SURFACES	CONDITIONED AIR

Transport Systems are those that involve mechanical operations in the process of carrying water, power or air to or from the locations at which they are used. Conditioned air is defined as the atmospheric environment at a particular location. It is intended to be a static definition rather than the dynamic system implied by HVAC.

The relationships described in the matrices following Section 5 are limited to those involving surfaces only. The methodology can be used to describe Activity/Physical Element interactions, forces, effects and properties for Structure, Transport Systems and Conditioned Air in the same manner as it will be shown applied to Surfaces.

1.1 Structure
- Foundation
- Floor-Ceiling
- Walls
- Roof
- Accessories
- Assemblies

1.2 Surfaces
- 1.2.1 Interior
  - Walls
  - Ceilings
  - Floors
  - Work Surfaces
  - Assemblies/Accessories
- 1.2.2 Exterior
  - Walls
  - Roof
  - Floors
  - Assemblies/Accessories

1.3 Transport Systems
- Plumbing
- Electrical Supply
- HVAC

1.4 Conditioned Air

2. List User ACTIVITIES, Site-Climate PHENOMENA

2.1 User ACTIVITIES

2.1.1 The randomly occurring GROSS MOTOR ACTIVITIES through which the user produces forces are:

Running	Lying	Rubbing
Walking	Falling	Twisting
Standing	Lifting	Pushing
Jumping	Hitting	Pulling
Kicking	Scratching	Sitting
		Misc. Hand Manipulations

2.1.2 All of the above Gross Motor Activities occur to some extent or degree during the performance of the following PLACE RELATED ACTIVITIES which have been grouped in seven categories based on conventional life styles.

FOOD PREPARATION
- Precooking (washing, sorting, cutting, chopping, blending, trashing)
- Cooking (boiling, broiling, baking, frying)
- Serving
- Clean-up (wash, drying, trashing)

EATING
- Serving
- Dining
- Clean-up (remove, trash)

SLEEPING
- Undress
- Sleep (rest, medical care, sex)
- Dress (cosmetic preparation)

LAUNDERING
- Washing (bleaching, dying)
- Drying

PERSONAL SANITATION
- Showering/Bathing
- Defecating/Urinating
- Drying
- Washing
- Medical/Cosmetic Care
- Laundering

RECREATION
- Hobbying (arts, crafts)
- Studying (reading, writing)
- Resting
- Sports/Gaming (Ping Pong, Darts, Monopoly)

2.1.2 CONTINUED

MAINTENANCE/REPAIR

Sewing/Ironing
Washing
Dusting (sweeping, vacuuming)
Painting/Papering
Fixing (plumbing, wiring, structure, fixtures, accessories, assemblies, appliances)

2.2 Climate PHENOMENA

The climatological PHENOMENA which impose forces upon the exterior elements of a dwelling are:

Rain	Humid Air	High Temperature
Snow	Dry Air	Low Temperature
Sleet	Wind	High-Low Temperature Cycle
Hail	Solar Radiation	

2.3 Site PHENOMENA

The Site PHENOMENA which impose forces upon the exterior elements of a dwelling are:

Earth Movement	Soil Biology	Atmospheric Chemistry (solid/liquid particulates in air, chemical air pollutants)
Soil Chemistry	Atmospheric Biology	

3. List FORCES

The Science of Kinesiology is concerned with the measurement of forces generated by movement of the human body. Efforts in this field have, thus far, been primarily in the areas of space and athletics programs. Data is extremely sparce on the forces generated by the users of buildings during the performance of their everyday activities.

All of the forces generated by all of the activities and phenomena described above can be defined in terms of four fundamental force categories as follows:

Static Physical	Chemical
Dynamic Physical	Biological

3.1 User FORCES

3.1.1 Physical

3.1.1.1 Static

Indentation Load
Thermal Energy, Radiant Energy

3.1.1.2 Dynamic

Impact Load	Shear
Friction	Compression Load
Indentation Load	Tension

3.1.2 Chemical

Acids	Water
Bases	Reactive Gases
Salts/Minerals	Organic Waxes
Organic Solvents	Organic Greases/Oils
Radiant Energy	Thermal Energy

3.1.3 Biological

- Bacteria/Virus
- Parasites

3.2 Climate FORCES

3.2.1 Physical

3.2.1.1 Static

- Indentation Load
- Thermal/Radiant Energy

3.2.1.2 Dynamic

Impact Load	Shear
Friction	Compression Load
Indentation Load	Tension

3.2.2 Chemical

- Water
- Thermal/Radiant Energy

3.3 Site FORCES

3.3.1 Physical

3.3.1.1 Static

- Indentation Load
- Thermal Energy

3.3.1.2 Dynamic

- Indentation Load
- Shear
- Compression Load

3.3.2 Chemical

Acids	Reactive Gases
Salts/Minerals	Organic Greases/Oils
Water	

3.3.3 Biological

Bacteria/Virus	Pets	Pests
Insects	Rodents	Misc. Native Wildlife
Parasites	Birds	Micro/Macro Flora

4. List EFFECTS

EFFECTS are defined as changes in the physical, chemical or biological state of materials or systems. The intrinsic nature or original level of performance of a material or system is altered to some extent through usage and the incurred alteration (change) is the effect.

EFFECTS can be described in terms of a limited number of basic

parameters which may or may not be specific for dynamic systems or static materials.

4.1 EFFECTS on Structures

4.2 EFFECTS on Surfaces

4.3 EFFECTS on Transport Systems

4.4 EFFECTS on Conditioned Air

4.2 EFFECTS on Surfaces

Primary Definition	Examples
Dimensional Change	Expansion, Contraction, Compression
Combustion	Burning, Smoldering, Smoking
Thermal Transfer	Heat Transmission, Cold Transmission
Acoustic Transfer	Noise Transmission, Vibration
Air Transfer	Leaking, Dust Infiltration
Moisture Transfer	Leaking, Penetration
Voids	Open Spaces
Contamination (Biol.)	Mold Growth
Hazard (Physical)	Slipperiness, Abrasiveness
Toxicity	Chemical Transformation, Absorption
Substrate Exposure	Peel, Scratch, Crack, Abrade
Surface Change	Wear, Color, Gloss, Fictional Resist.
Absorption	Chemical Stain

5. List PROPERTIES: REQUIREMENTS

5.1 PROPERTIES of Structure

5.2 PROPERTIES of Surfaces

5.3 PROPERTIES of Transport Systems

5.4 PROPERTIES of Conditioned Air

See Appendix B for commentary on Properties.

5.2 PROPERTIES of Surfaces

5.2.1 Primary Properties

Hardness	Chemical Inertness
Resilience	Impermeability
Adhesion	Non-Absorptivity
Cohesion	Thermal Stability
Color	Biological Inertness

5.2.2 Secondary Properties

Abrasion Resist. Moisture Impermeability

Acoustic Control	Reflectivity
Blister Resistance	Scratch Resistance
Chalking Resistance	Scrub Resistance
Color Retention	Spotting Resistance
Compressive Strength	Stain Resistance
Corrosion Resistance	Tensile Strength
Cracking Resistance	Washability
Dimensional Stability	Skid Resistance
Elasticity	Roughness
Fire Retardancy	Heat Capacity
Flexibility	Porosity
Gloss Retention	Humidity Resistance
Impact Strength	Indentation Resistance
Light Fastness	Mildew Resistance

6. Identify which PHYSICAL ELEMENTS are involved with which ACTIVITIES/PHENOMENA.

6.1 User ACTIVITIES involved with PHYSICAL ELEMENTS
- 6.1.1 Structure
- 6.1.2 Surfaces
- 6.1.3 Transport Systems
- 6.1.4 Conditioned Air

6.2 Climate PHENOMENA involved with PHYSICAL ELEMENTS
- 6.2.1 Structure
- 6.2.2 Surfaces
- 6.2.3 Transport Systems
- 6.2.4 Conditioned Air

6.3 Site PHENOMENA involved with PHYSICAL ELEMENTS
- 6.3.1 Structure
- 6.3.2 Surfaces
- 6.3.3 Transport Systems
- 6.3.4 Conditioned Air

6.1.2 User ACTIVITIES involved with SURFACES

6.1.2.1 Gross Motor Activities

	SURFACES										
	Interior						Exterior				
RANDOM GMA	Walls	Ceilings	Floors	Work Surfaces	Assemb/Access		Walls	Roof	Floors	Assemb/Access	
Running			X						X		
Walking			X					X	X		
Standing			X					X	X		
Jumping			X					X	X		
Kicking	X				X		X			X	
Lying			X						X		
Falling	X		X		X		X		X	X	
Lifting			X						X		
Hitting	X	X	X	X	X		X	X	X	X	
Scratching	X	X	X	X	X		X			X	
Rubbing	X	X	X	X	X		X			X	
Twisting					X					X	
Pushing	X			X	X		X			X	
Pulling					X					X	
Sitting			X		X			X			
Misc. Manip.					X					X	

6.1.2.2 Place Related Activities.

PLACE RELATED ACTIVITIES	SURFACES										
	Interior						Exterior				
	Walls	Ceilings	Floors	Work Surfaces	Assemb/Access		Walls	Roof	Floors	Assemb/Access	
Food Prep											
Precooking	X		X	X	X						
Cooking	X	X	X	X	X						
Serving			X	X	X						
Clean-Up				X	X						
Eating											
Serving	X		X	X	X						
Dining	X		X	X	X						
Clean-Up				X	X						
Sleeping											
Undress	X		X		X						
Sleep			X		X						
Dress	X		X	X	X						
Laundering											
Washing	X	X	X	X	X						
Drying	X			X	X						
Pers. Sanit.											
Shower/Bathe	X	X	X	X	X						
Defec/Urin.			X		X						
Dry			X								
Wash	X		X	X	X						
Med/Cosm.	X		X	X	X						
Laundering	X		X	X	X						
Recreation											
Hobbying	X		X	X	X				X		
Studying				X							
Resting					X						
Commun.				X	X						
Sports	X		X	X	X		X		X		
Maint./Repair											
Sew/Iron				X	X						
Wash	X	X	X	X	X		X				
Dust	X		X	X	X						
Paint	X	X	X	X	X		X		X	X	
Fix	X	X	X	X	X		X	X	X	X	

6.2.2 Climate PHENOMENA involved with SURFACES.

CLIMATE PHENOMENA	SURFACES				
	Exterior Walls	Roof	Floors	Assemb/Access
Rain	X	X	X	X
Snow	X	X	X	X
Sleet	X	X	X	X
Hail	X	X	X	X
Humid Air	X	X	X	X
Dry Air	X	X	X	X
Wind	X	X	X	X
Solar Rad.	X	X	X	X
High Temp.	X	X	X	X
Low Temp.	X	X	X	X
High-Low Cycle	X	X	X	X

6.3.2 Site PHENOMENA involved with SURFACES.

SITE PHENOMENA	SURFACES										
	Interior						Exterior				
	Walls	Ceilings	Floors	Work Surfaces	Assemb/Access		Walls	Roof	Floors	Assemb/Access	
Earth Movement	X	X	X				X		X		
Soil Chemistry							X		X	X	
Soil Biology	X	X	X	X	X		X		X	X	
Atmospheric Chemistry							X	X	X	X	
Atmospheric Biology							X	X	X	X	

7. Identify which FORCES are generated by which ACTIVITIES/ PHENOMENA.

7.1 FORCES generated by User ACTIVITIES.

7.1.1 Randomly occurring Gross Motor Activities generating Physical Forces.

RANDOM GROSS MOTOR ACTIVITIES	Indentation Static	Thermal Energy	Impact	Friction	Indentation Dynamic	Shear	Compression	Tension
Running		X	X	X	X		X	
Walking		X	X	X	X		X	
Standing	X						X	
Jumping			X		X		X	
Kicking		X	X	X	X	X	X	
Lying	X						X	
Falling		X	X	X			X	
Lifting					X		X	
Hitting		X	X	X	X	X	X	
Scratching		X		X		X		
Rubbing		X		X				
Twisting		X		X		X		
Pushing	X				X	X	X	X
Pulling								X
Sitting	X		X		X		X	
Misc. Manip.								

7.1.2 User Place Related ACTIVITIES generating Chemical and Biological Forces.

PLACE RELATED ACTIVITIES

	Acids	Bases	Salts/Minerals	Organic Solv.	Water	Gases	Waxes	Greases/Oil	Thermal Energy	Bacteria/Virus	Parasites	Radiant Energy
Food Prep.												
Precooking	X				X			X	X	X	X	X
Cooking			X		X	X		X	X	X	X	X
Serving					X			X	X	X	X	X
Clean-Up	X	X	X	X	X	X		X	X	X	X	X
Eating												
Serving	X				X			X	X	X	X	X
Dining			X	X	X			X	X	X	X	X
Clean-Up					X	X	X	X		X	X	X
Sleeping												
Undress										X		X
Sleep			X	X	X	X			X	X	X	X
Dress				X				X		X		X
Laundering												
Washing		X	X	X	X				X	X		X
Drying									X	X		X
Pers. Sanit.												
Showering					X				X	X		X
Defec./Urin.	X									X	X	X
Dry										X		X
Wash			X		X					X		X
Med./Cosm.				X	X	X	X	X	X	X	X	X
Laundering		X			X	X			X	X		X
Recreation												
Hobbying	X	X	X	X	X	X	X	X	X	X	X	X
Studying										X		X
Resting				X	X					X		X
Commun.										X		X
Sports										X		X
Maint./Repair												
Sew/Iron					X	X			X	X		X
Wash			X	X	X	X			X	X		X
Dust										X		X
Paint				X	X	X		X				X
Fix	X	X	X	X	X	X	X	X	X			X

7.2 Climate FORCES generated by climate PHENOMENA

CLIMATE PHENOMENA	CLIMATE FORCES									
	Static Indent.	Thermal Energy	Radiant Energy	Impact	Friction	Dynamic Indent.	Shear	Compression	Tension	Water
Rain		X		X	X					X
Snow	X	X						X		X
Sleet		X		X	X					X
Hail		X		X	X	X				
Humid Air										X
Dry Air		X								
Wind				X			X	X	X	
Solar Rad.		X	X							
High Temp.		X					X	X	X	
Low Temp.		X					X	X	X	
High-Low Temp. Cycles		X					X	X	X	

7.3 Site FORCES generated by Site PHENOMENA.

SITE PHENOMENA	SITE FORCES																		
	Static Indent.	Thermal Energy	Dynamic Indent.	Shear	Compression	Acids	Salts/Minerals	Gases	Water	Greases/Oils	Bacteria/Virus	Insects	Parasites	Pets	Rodents	Birds	Pests	Misc. Wildlife	Micro Flora	Macro Flora
Earth Movement	X		X	X	X															
Soil Chemistry							X		X											
Soil Biology											X	X	X		X		X	X	X	X
Atmospheric Chemistry		X				X	X	X	X	X										
Atmospheric Biology											X	X		X		X	X	X	X	X

8. Identify which EFFECTS result from which FORCES.

8.1 EFFECTS resulting from user FORCES

EFFECTS

FORCES	Dimensional Change	Combustion	Thermal Transfer	Acoustic Transfer	Air Transfer	Moisture Transfer	Voids	Contamination (Bio.)	Hazard (Physical)	Toxicity	Substrate Exposure	Surface Degradation	Absorption
PHYSICAL													
Static Indent.	X											X	X
Thermal Energy	X	X					X					X	X
Impact	X		X	X				X			X	X	X
Friction	X		X	X							X	X	X
Dyanmic Indent.	X		X								X	X	X
Shear								X			X	X	
Compression	X							X			X	X	
Tension	X							X			X	X	
CHEMICAL/BIOLOGICAL													
Acids	X								X	X		X	X
Bases	X								X	X		X	X
Salts/Minerals	X								X	X		X	X
Organic Solv.	X	X							X	X		X	X
Water	X						X			X		X	X
Gases										X	X		X
Waxes					X		X				X		X
Greases/Oils	X			X	X		X		X	X	X	X	X
Thermal Energy	X	X					X				X	X	X
Radiant Energy	X										X	X	X
Bacteria/Virus	X							X		X		X	X
Parasites	X							X		X		X	X

8.2 EFFECTS resulting from climate FORCES.

EFFECTS	CLIMATE: Static Indent.	Thermal Energy	Radiant Energy	Impact	Friction	Dynamic Indent.	Shear	Compression	Tension	Water
Dimensional Change	X	X				X				X
Combustion										
Thermal Transfer		X		X	X	X				
Acoustic Transfer				X	X					
Air Transfer										
Moisture Transfer		X								X
Voids				X		X	X	X	X	
Contamination (Biol.)										
Hazard (Physical)				X		X	X	X	X	
Toxicity										
Substrate Exposure				X	X	X	X	X	X	
Surface Degradation	X	X		X	X	X	X	X	X	X
Absorption	X	X		X	X	X				X

8.3 EFFECTS resulting from site FORCES.

EFFECTS	SITE: Static Indent.	Thermal Energy	Dynamic Indent.	Shear	Compression	Acids	Salts/Minerals	Water	Gases	Greases/Oils	Bacteria/Virus	Insects	Parasites	Pets	Rodents	Birds	Pests	Misc. Wildlife	Micro Flora	Macro Flora
Dimensional Change	X	X	X			X	X	X		X										
Combustion		X																		
Thermal Transfer		X	X																	
Acoustic Transfer																				
Air Transfer										X										
Moisture Transfer		X						X		X										
Voids	X		X	X	X															
Contamination (Biol.)											X	X	X	X	X	X	X	X	X	X
Hazard (Physical)			X	X	X										X		X	X		
Toxicity						X	X		X	X	X	X	X	X	X	X	X	X	X	X
Substrate Exposure			X	X	X										X		X			
Surface Degradation	X	X	X	X	X	X	X	X	X	X	X			X					X	
Absorption	X	X	X			X	X	X	X	X	X								X	

9. Identify which PROPERTIES control which EFFECTS.

9.1 PROPERTIES controlling EFFECTS on Structure.

9.2 PROPERTIES controlling EFFECTS on Surface.

9.3 PROPERTIES controlling EFFECTS on Transport Systems.

9.4 PROPERTIES controlling EFFECTS on Conditioned Air.

9.2 PROPERTIES controlling EFFECTS on SURFACES.

Primary	Dimensional Change	Combustion	Thermal Transfer	Acoustic Transfer	Air Transfer	Moisture Transfer	Voids	Contamination	Hazard	Toxicity	Substrate Exposure	Surface Change	Absorption
Hardness	X			X					X		X	X	X
Resilience	X			X					X			X	X
Adhesion									X		X		
Cohesion	X						X				X	X	
Color												X	
Chemical Inertness	X	X								X		X	X
Impermeability					X	X		X	X			X	X
Non-Absorptivity	X		X	X	X	X		X	X			X	X
Thermal Stability	X	X	X						X			X	X
Biological Inertness								X		X		X	X

9.2 Continued

Secondary	Dimensional Change	Combustion	Thermal Transfer	Acoustic Transfer	Air Transfer	Moisture Transfer	Voids	Contamination	Hazard	Toxicity	Substrate Exposure	Surface Change	Absorption
Abrasion Resist											X	X	
Acoustic Control				X									
Blister Resist.												X	
Chalking Resist.											X	X	
Color Retention												X	
Compressive Strength												X	
Corrosion Resist.												X	
Cracking Resist.							X				X	X	
Dimensional Stability	X										X	X	
Elasticity												X	
Fire-Retardancy		X							X		X	X	
Flexibility							X					X	
Gloss Retention												X	X
Humidity Resist.												X	X
Impact Strength											X		
Indentation Resist.												X	
Light Fastness												X	
Mildew Resist								X		X		X	X
Moisture Impermeability						X							X
Reflectivity												X	X
Scratch Resist.											X	X	
Scrub Resist.											X	X	
Spotting Resist.												X	X
Stain Resist.								X				X	X
Tensile Strength											X		
Washability								X				X	
Skid Resistance									X				
Roughness									X			X	

10. ANALYZE which FORCES are involved with which PHYSICAL ELEMENTS.

The relationships of Forces and Physical Elements are derived from the Analysis of two other relationships:

Activities/Phenomena related to Forces [7].

Activities/Phenomena related to Physical Elements [6].

10.1 User, Climate, Site FORCES involved with STRUCTURE.

10.2 User, Climate, Site FORCES involved with SURFACES.

10.3 User, Climate, Site FORCES involved with TRANSPORT SYSTEMS.

10.4 User, Climate, Site FORCES involved with CONDITIONED AIR.

10.2 User, Climate, Site FORCES involved with SURFACES.

10.2.1 User FORCES.

10.2.1.1 Physical User FORCES.

SURFACES	Indentation Static	Thermal Energy	Radiant Energy	Impact	Friction	Indentation Dynamic	Shear	Compression	Tension
Interior									
Walls	X	X	X	X	X	X	X	X	X
Ceilings		X	X	X	X	X	X	X	
Floors	X	X	X	X	X	X	X	X	
Work Surfaces	X	X	X	X	X	X	X	X	X
Assemb./Access	X	X	X	X	X	X	X	X	X
Exterior									
Walls	X	X	X	X	X	X	X	X	X
Roof	X	X	X	X	X	X	X	X	
Floors		X	X	X	X	X	X	X	X
Assemb./Access	X	X	X	X	X	X	X	X	X

SURFACES	Acids	Bases	Salts/Minerals	Organic Solv.	Water	Gases	Waxes	Greases/Oils	Bacteria/Virus	Parasites	Thermal Energy	Radiant Energy
Food Prep.												
Int. Walls	X		X		X	X		X	X	X	X	X
Ceilings			X		X	X		X	X	X	X	X
Floors	X		X		X	X		X	X	X	X	X
Work Surf.	X	X	X	X	X	X		X	X	X	X	X
Ass./Acc.	X	X	X	X	X	X		X	X	X	X	X
Eating												
Int. Walls	X		X	X	X			X	X	X	X	X
Ceilings												
Floors	X		X	X	X			X	X	X	X	X
Work Surf.	X		X	X	X	X		X	X	X	X	X
Ass./Acc.	X		X	X	X	X		X	X	X	X	X
Sleeping												
Int. Walls				X				X	X			X
Ceilings												X
Floors			X	X	X	X		X	X	X	X	X
Work Surf.				X				X	X			X
Ass./Acc.			X	X	X	X		X	X	X	X	X
Laundering												
Int. Walls		X	X	X	X				X		X	X
Ceilings		X	X	X	X				X		X	X
Floors		X	X	X	X				X		X	X
Work Surf.		X	X	X	X				X		X	X
Ass./Acc.		X	X	X	X				X		X	X
Personal Sanitation												
Int. Walls		X	X	X	X	X	X	X	X	X	X	X
Ceilings					X				X		X	X
Floors	X	X	X	X	X	X	X	X	X	X	X	X
Work Surf.		X	X	X	X	X	X	X	X	X	X	X
Ass./Acc.	X	X	X	X	X	X	X	X	X	X	X	X

SURFACES		Acids	Bases	Salts/Minerals	Organic Solv.	Water	Gases	Waxes	Greases/Oils	Bacteria/Virus	Parasites	Thermal Energy	Radiant Energy
Recreation													
Int.	Walls	X	X	X	X	X	X	X	X	X	X	X	X
	Ceilings												X
	Floors	X	X	X	X	X	X	X	X	X	X	X	X
	Work Surf.	X	X	X	X	X	X	X	X	X	X	X	X
	Ass./Acc.	X	X	X	X	X	X	X	X	X	X	X	X
Ext.	Walls									X			
	Roof												
	Floors	X	X	X	X	X	X	X	X	X	X	X	
	Ass./Acc.												
Maint./Repair													
Int.	Walls	X	X	X	X	X	X	X	X	X		X	X
	Ceilings	X	X	X	X	X	X	X	X	X		X	X
	Floors	X	X	X	X	X	X	X	X	X		X	X
	Work Surf.	X	X	X	X	X	X	X	X	X		X	X
	Ass./Acc.	X	X	X	X	X	X	X	X	X		X	X
Ext.	Walls	X	X	X	X	X	X	X	X	X		X	
	Roof	X	X	X	X	X	X	X	X	X		X	
	Floors	X	X	X	X	X	X	X	X	X		X	
	Ass./Acc.	X	X	X	X	X	X	X	X	X		X	

10.2.2 Climate Forces

CLIMATE FORCES

SURFACES	Static Indent.	Thermal Energy	Radiant Energy	Impact	Friction	Dynamic Indent.	Shear	Compression	Tension	Water
Exterior										
Walls	X	X	X	X	X	X	X	X	X	X
Roof	X	X	X	X	X	X	X	X	X	X
Floors	X	X	X	X	X	X	X	X	X	X
Assemb/Access	X	X	X	X	X	X	X	X	X	X

10.2.3 Site FORCES

SITE FORCES

SURFACES	Static Indent.	Thermal Energy	Dynamic Indent.	Shear	Compression	Acids	Salt/Minerals	Gases	Water	Greases/Oils	Bacteria/Virus	Insects	Parasites	Pets	Rodents	Birds	Pests	Misc. Wildlife	Micro Flora	Macro Flora
Interior																				
Walls	X		X	X	X			X			X	X	X		X		X	X	X	X
Ceilings	X		X	X	X			X			X	X	X		X		X	X	X	X
Floors	X		X	X	X			X			X	X	X		X		X	X	X	X
Work Surf.								X			X	X	X		X		X	X	X	X
Ass./Acc.								X			X	X	X		X		X	X	X	X
Exterior																				
Walls	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Roof		X				X	X	X	X	X	X	X			X	X	X	X	X	X
Floors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ass./Acc.		X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

11. Analyze which EFFECTS occur to which PHYSICAL ELEMENTS.

The relationships of Effects to Physical Elements are derived from the analysis of two other relationships:

Forces related to PHYSICAL ELEMENTS [6].

Forces related to EFFECTS [8].

11.1 EFFECTS occurring to STRUCTURE.

11.2 EFFECTS occurring to SURFACES.

11.3 EFFECTS occurring to TRANSPORT SYSTEMS.

11.4 EFFECTS occurring to CONDITIONED AIR.

11.2 EFFECTS occurring to Surfaces.

11.2.1 User Effects occurring to Surfaces.

11.2.1.1 Physical User Effects on Surfaces.

SURFACES

	Dimensional Change	Combustion	Thermal Transfer	Acoustic Transfer	Air Transfer	Moisture Transfer	Voids	Contamination	Hazard	Toxicity	Substrate Exposure	Surface Degradation	Absorption
Interior													
Walls	X	X	X	X		X	X				X	X	X
Ceilings	X	X	X	X		X	X				X	X	X
Floors	X	X	X	X		X	X				X	X	X
Work Surfaces	X	X	X	X		X	X				X	X	X
Assemb/Access	X	X	X	X		X	X				X	X	X
Exterior													
Walls	X	X	X	X		X	X				X	X	X
Roof	X	X	X	X		X	X				X	X	X
Floors	X	X	X	X		X	X				X	X	X
Assemb/Access	X	X	X	X		X	X				X	X	X

11.2.1.2 Chemical, Biological User Effects on Surfaces.

SURFACES

	Dimensional Change	Combustion	Thermal Transfer	Acoustic Transfer	Air Transfer	Moisture Transfer	Voids	Contamination	Hazard	Toxicity	Substrate Exposure	Surface Degradation	Absorption
Food Prep.													
Int. Walls	X	X	X		X	X		X	X	X	X	X	X
Ceilings	X	X	X		X	X		X	X	X	X	X	X
Floors	X	X	X		X	X		X	X	X	X	X	X
Work Surf.	X	X	X		X	X		X	X	X	X	X	X
Assemb/Acc.	X	X	X		X	X		X	X	X	X	X	X
Eating													
Int. Walls	X	X	X		X	X		X	X	X	X	X	X
Ceilings													
Floors	X	X	X		X	X		X	X	X	X	X	X
Work Surf.	X	X	X		X	X		X	X	X	X	X	X
Assemb/Acc.	X	X	X		X	X		X	X	X	X	X	X
Sleeping													
Int. Walls	X	X								X		X	X
Ceilings													
Floors	X	X	X		X	X		X	X	X	X	X	X
Work Surf.	X	X	X		X	X		X	X	X	X	X	X
Assemb/Acc.	X	X	X		X	X		X	X	X	X	X	X
Laundering													
Int. Walls	X	X	X			X		X	X	X	X	X	X
Ceilings	X	X	X			X		X	X	X	X	X	X
Floors	X	X	X			X		X	X	X	X	X	X
Work Surf.	X	X	X			X		X	X	X	X	X	X
Assemb/Acc.	X	X	X			X		X	X	X	X	X	X
Personal Sanit.													
Int. Walls	X	X	X		X	X		X	X	X	X	X	X
Ceilings	X	X	X		X	X			X	X	X	X	X
Floors	X	X	X		X	X		X	X	X	X	X	X
Work Surf.	X	X	X		X	X		X	X	X	X	X	X
Assemb/Acc.	X	X	X		X	X		X	X	X	X	X	X

Continued

11.2.1.2 Continued.

SURFACES	Dimensional Change	Combustion	Thermal Transfer	Acoustic Transfer	Air Transfer	Moisture Transfer	Voids	Contamination	Hazard	Toxicity	Substrate Exposure	Surface Degradation	Absorption
Recreation													
Int. Walls	X	X	X		X	X		X	X	X	X	X	X
Ceilings													
Floors	X	X	X		X	X		X	X	X	X	X	X
Work Surf.	X	X	X		X	X		X	X	X	X	X	X
Assemb/Acc.	X	X	X		X	X		X	X	X	X	X	X
Ext. Walls								X		X		X	X
Roof													
Floors	X	X	X		X	X		X	X	X	X	X	X
Assemb/Acc.													
Maint./Repair													
Int. Walls	X	X	X		X	X		X	X	X	X	X	X
Ceiling	X	X	X		X	X		X	X	X	X	X	X
Floors	X	X	X		X	X		X	X	X	X	X	X
Work Surf.	X	X	X		X	X		X	X	X	X	X	X
Assemb/Acc.	X	X	X		X	X		X	X	X	X	X	X
Ext. Walls	X	X	X		X	X		X	X	X	X	X	X
Roof	X	X	X		X	X		X	X	X	X	X	X
Floors	X	X	X		X	X		X	X	X	X	X	X
Assemb/Acc.	X	X	X		X	X		X	X	X	X	X	X

11.2.2 Climate Effects on Surfaces.

11.2.3 Site effects on Surfaces.

SURFACES	Dimensional Change	Combustion	Thermal Transfer	Acoustic Transfer	Air Transfer	Moisture Transfer	Voids	Contamination	Hazard	Toxicity	Substrate Exposure	Surface Degradation	Absorption	
Exterior														
Walls	X		X	X	X	X	X		X	X	X	X	X	
Roof	X		X	X	X	X	X		X	X	X	X	X	CLIMATE
Floors	X		X	X	X	X	X		X	X	X	X	X	
Assemb/Acc.	X		X	X	X	X	X		X	X	X	X	X	

SURFACES	Dimensional Change	Combustion	Thermal Transfer	Acoustic Transfer	Air Transfer	Moisture Transfer	Voids	Contamination	Hazard	Toxicity	Substrate Exposure	Surface Degradation	Absorption	
Interior														
Walls	X	X	X			X	X	X	X	X	X	X	X	
Ceilings	X		X				X	X	X	X	X	X	X	
Floors	X		X				X	X	X	X	X	X	X	
Work Surf.								X	X	X	X	X	X	SITE
Assemb/Acc.								X	X	X	X	X	X	
Exterior														
Walls	X	X	X			X	X	X	X	X	X	X	X	
Roof	X	X	X			X		X	X	X	X	X	X	
Floors	X	X	X			X	X	X	X	X	X	X	X	
Assemb/Acc.	X	X	X			X		X	X	X	X	X	X	

12. Analyze which PROPERTIES are REQUIRED for which PHYSICAL ELEMENTS.

12.1 PROPERTIES required for STRUCTURE.

12.2 PROPERTIES required for SURFACES.

12.3 PROPERTIES required for TRANSPORT SYSTEMS.

12.4 PROPERTIES required for CONDITIONED AIR.

The relationships of Properties and Physical Elements are derived from the analysis of two other relationships:
Effects related to PHYSICAL ELEMENTS [11].
Effects related to PROPERTIES [9].

12.2 Properties required for Surfaces

12.2.1 User Forces and Effects

Primary Properties

SURFACES	Hardness	Resilience	Adhesion	Cohesion	Color	Chemical Inertness	Impermeability	Thermal Stability	Biological Inertness	Non-Absorptivity
Interior										
Walls	X	X	X	X	X	X	X	X	X	X
Floors	X	X	X	X	X	X	X	X	X	X
Ceilings	X	X	X	X	X	X	X	X	X	X
Work Surfaces	X	X	X	X	X	X	X	X	X	X
Acc./Assemb.	X	X	X	X	X	X	X	X	X	X
Exterior										
Walls	X	X	X	X	X	X	X	X	X	X
Floors	X	X	X	X	X	X	X	X	X	X
Roof	X	X	X	X	X	X	X	X	X	X
Acc./Assemb.	X	X	X	X	X	X	X	X	X	X

Secondary Properties

SURFACES	Abrasion Resistance	Acoustic Control	Blister Resistance	Chalking Resistance	Color Retention	Compressive Strength	Corrosion Resistance	Cracking Resistance	Dimensional Stability	Elasticity	Fire Retardancy	Flexibility	Gloss Retention	Humidity Resistance	Impact Strength	Indentation Resistance	Light Fastness	Mildew Resistance	Moisture Impermeability	Reflectivity	Roughness	Scratch Resistance	Scrub Resistance	Spotting Resistance	Stain Resistance	Skid Resistance	Tensile Strength	Washability
Interior																												
Walls	X										X		X	X				X	X	X	X	X	X	X	X			X
Floors	X	X				X		X	X		X			X	X	X		X	X		X	X			X	X		X
Ceilings											X		X	X				X	X	X								X
Work Surfaces	X							X	X		X			X	X			X	X		X	X	X	X	X			X
Acc./Assemb.									X		X			X				X	X									X
Exterior																												
Walls											X				X	X						X			X			
Floors	X					X					X				X	X						X			X			
Roof											X				X													
Acc./Assemb.											X														X			X

12.2 Properties Required for Surfaces

12.2.2 Climate Forces and Effects

SURFACES	Primary Properties	Hardness	Resilience	Adhesion	Cohesion	Color	Chemical Inertness	Impermeability	Thermal Stability	Biological Inertness	Non-Absorptivity	Secondary Properties	Abrasion Resistance	Acoustic Control	Blister Resistance	Chalking Resistance	Color Retention	Compressive Strength	Corrosion Resistance	Cracking Resistance	Dimensional Stability	Elasticity	Fire Retardancy	Flexibility	Gloss Retention	Humidity Resistance	Impact Strength	Indentation Resistance	Light Fastness	Mildew Resistance	Moisture Impermeability	Reflectivity	Roughness	Scratch Resistance	Scrub Resistance	Spotting Resistance	Stain Resistance	Skid Resistance	Tensile Strength	Washability
Interior																																								
Walls																	X												X											
Floors																																								
Ceilings																																								
Work Surfaces																																								
Acc./Assemb.																																								
Exterior																																								
Walls		X	X	X	X	X	X	X	X	X	X		X		X	X	X			X	X	X		X	X	X	X		X		X	X								
Floors		X	X	X	X	X	X	X	X	X	X										X					X	X				X									
Roof		X	X	X	X	X	X	X	X	X	X				X					X	X	X		X		X	X				X	X								
Acc./Assemb.		X	X	X	X	X	X	X	X	X	X				X	X	X			X	X	X		X	X	X			X		X									

12.2 Properties Required for Surfaces

12.2.3 Site Forces and Effects

SURFACES	Primary Properties	Hardness	Resilience	Adhesion	Cohesion	Color	Chemical Inertness	Impermeability	Thermal Stability	Biological Inertness	Non-Absorptivity	Secondary Properties	Abrasion Resistance	Acoustic Control	Blister Resistance	Chalking Resistance	Color Retention	Compressive Strength	Corrosion Resistance	Cracking Resistance	Dimensional Stability	Elasticity	Fire Retardancy	Flexibility	Gloss Retention	Humidity Resistance	Impact Strength	Indentation Resistance	Light Fastness	Mildew Resistance	Moisture Impermeability	Reflectivity	Roughness	Scratch Resistance	Scrub Resistance	Spotting Resistance	Stain Resistance	Skid Resistance	Tensile Strength	Washability
Interior																																								
Walls		X	X	X	X	X	X	X	X	X	X		X				X						X							X						X				
Floors		X	X	X	X	X	X	X	X	X	X								X				X							X						X				
Ceilings																																								
Work Surfaces																																								
Acc./Assemb.																																								
Exterior																																								
Walls		X	X	X	X	X	X	X	X	X	X		X				X		X				X							X						X				
Floors		X	X	X	X	X	X	X	X	X	X																														
Roof		X	X	X	X	X	X	X	X	X	X								X				X							X						X				
Acc./Assemb.		X	X	X	X	X	X	X	X	X	X		X				X		X				X							X						X				

Appendix A

This section contains performance requirement statements for the interior and exterior surfaces of a building. The statements refer implicitly or explicitly to the primary and applicable secondary properties identified in Section 12. The methodology can be used to derive Requirement statements for Structure, Transport Systems and Conditioned Air by means of the same analytical procedures used for Surfaces.

A.1 Requirements for Interior Walls

Requirement 1
The Wall Surfaces should provide protection of the substrate from the effects of maintenance, normal usage and the interior environment.

Requirement 2
The Wall Surface should not contribute to user hazard.

Requirement 3
The Wall Surface should retain its designed decorative characteristics.

Primary Properties
- Hardness
- Resilience
- Adhesion
- Cohesion
- Color
- Chemical Inertness
- Impermeability
- Thermal Stability
- Biological Inertness
- Non-Absorptivity

Secondary Properties
- Abrasion Resistance
- Color Retention
- Cracking Resistance
- Elasticity
- Fire Retardancy
- Flexibility
- Gloss Retention
- Humidity Resistance
- Light Fastness
- Mildew Resistance
- Moisture Impermeability
- Reflectivity
- Roughness
- Scratch Resistance
- Scrub Resistance
- Spotting Resistance
- Stain Resistance
- Washability

A.2 Requirements for Interior Ceilings.

Requirement 1
The Ceiling Surface should provide protection of the substrate from the effects of maintenance, normal usage and the interior environment.

Requirement 2
The Ceiling Surface should not contribute to user hazard.

Requirement 3
The Ceiling Surface should retain its designed decorative characteristics.

Primary Properties
- Hardness
- Resilience
- Adhesion
- Cohesion
- Color
- Chemical Inertness
- Impermeability
- Thermal Stability
- Biological Inertness
- Non-Absorptivity

Secondary Properties
- Blister Resistance
- Color Retention
- Cracking Resistance
- Elasticity
- Fire Retardancy
- Flexibility
- Gloss Retention
- Humidity Resistance
- Mildew Resistance
- Moisture Impermeability
- Reflectivity
- Washability

A.3 Requirements for Interior Floors

Requirement 1
The Surface Wear Layer should protect sublayers and subfloors from the effects of maintenance, normal usage and the interior environment.

Requirement 2
The Surface Wear Layer should maintain its designed decorative characteristics.

Requirement 3
The Surface Wear Layer should not contribute to user hazard.

Requirement 4
The Surface Wear Layer should maintain the comfort characteristics generally designed for the generic flooring material type it represents.

Primary Properties
- Hardness
- Resilience
- Adhesion
- Cohesion
- Color
- Chemical Inertness
- Impermeability
- Thermal Stability
- Biological Inertness
- Non-Absorptivity

Secondary Properties
- Abrasion Resistance
- Acoustic Control
- Color Retention
- Compressive Strength
- Cracking Resistance
- Dimensional Stability
- Elasticity
- Fire Retardancy
- Flexibility
- Gloss Retention
- Humidity Resistance
- Impact Strength
- Indentation Resistance
- Mildew Resistance
- Moisture Impermeability
- Reflectivity
- Roughness
- Scratch Resistance
- Scrub Resistance
- Spotting Resistance
- Stain Resistance
- Skid Resistance
- Tensile Strength
- Washability

A.4 Requirements for Interior Work Surfaces

Requirement 1
The Work Surfaces should not have their functionality impaired by the effects of maintenance, normal usage and the interior environment.

Requirement 2
The Work Surfaces should not contribute to user hazard.

Requirement 3
The Work Surfaces should retain their designed decorative characteristics.

Primary Properties
- Hardness
- Resilience
- Adhesion
- Cohesion
- Color
- Chemical Inertness
- Impermeability
- Thermal Stability
- Biological Inertness
- Non-Absorptivity

Secondary Properties
- Abrasion Resistance
- Color Retention
- Cracking Resistance
- Dimensional Stability
- Fire Retardancy
- Flexibility
- Gloss Retention
- Humidity Resistance
- Impact Strength
- Indentation Resistance
- Mildew Resistance
- Moisture Impermeability
- Reflectivity
- Roughness
- Scratch Resistance
- Scrub Resistance
- Spotting Resistance
- Stain Resistance
- Washability

A.5 Requirements for Interior Accessories/Assemblies.

Requirement 1
The Surface should provide protection of the substrate from the effects of maintenance, normal usage and the interior environment.

Requirement 2
The Surface should not contribute to user hazard.

Requirement 3
The Surface should retain its designed decorative characteristics.

Requirement 4
Surface changes should not impair the functionality or operation of Accessories and Assemblies.

Primary Properties
- Hardness
- Resilience
- Adhesion
- Cohesion
- Color
- Chemical Inertness
- Impermeability
- Thermal Stability
- Biological Inertness
- Non-Absorptivity

Secondary Properties
- Abrasion Resistance
- Color Retention
- Compressive Strength
- Corrosion Resistance
- Cracking Resistance
- Dimensional Stability
- Elasticity
- Fire Retardancy
- Flexibility
- Gloss Retention
- Humidity Resistance
- Mildew Resistance
- Moisture Impermeability
- Reflectivity
- Roughness
- Scratch Resistance
- Scrub Resistance
- Spotting Resistance
- Stain Resistance
- Washability

A.6 Requirements for Exterior Walls

Requirement 1
The Wall Surface should provide protection of the substrate from the effects of maintenance, normal usage, and the exterior environment both above and below ground level.

Requirement 2
The Wall Surface should not contribute to user hazard.

Requirement 3
The Wall Surface should retain its designed decorative characteristics.

Primary Properties
- Hardness
- Resilience
- Adhesion
- Cohesion
- Color
- Chemical Inertness
- Impermeability
- Thermal Stability
- Biological Inertness
- Non-Absorptivity

Secondary Properties
- Abrasion Resistance
- Blister Resistance
- Chalking Resistance
- Color Retention
- Corrosion Resistance
- Cracking Resistance
- Dimensional Stability
- Elasticity
- Fire Retardancy
- Flexibility
- Gloss Retention
- Humidity Resistance
- Impact Strength
- Indentation Resistance
- Light Fastness
- Mildew Resistance
- Moisture Impermeability
- Reflectivity
- Scratch Resistance
- Spotting Resistance
- Stain Resistance

A.7 Requirements for Roof

Requirement 1
The Roof Surface should protect sublayers of the Roof System from the effects of maintenance, normal usage, weather and other exterior environmental factors.

Requirement 2
The Roof Surface should not contribute to user hazard.

Requirement 3
The Roof Surface should retain its designed decorative characteristics.

Primary Properties
- Hardness
- Resilience
- Adhesion
- Cohesion
- Color
- Chemical Inertness
- Impermeability
- Thermal Stability
- Biological Inertness
- Non-Absorptivity

Secondary Properties
- Blister Resistance
- Corrosion Resistance
- Cracking Resistance
- Dimensional Stability
- Elasticity
- Fire Retardancy
- Flexibility
- Humidity Resistance
- Impact Strength
- Mildew Resistance
- Moisture Impermeability
- Reflectivity
- Stain Resistance

A.8 Requirements for Exterior Floors

Requirement 1
The Floor Surface should resist the effects of maintenance, normal usage and the exterior environment.

Requirement 2
The Floor Surface should not contribute to user hazard.

Requirement 3
The Floor Surface should retain its designed decorative characteristics.

Primary Properties
- Hardness
- Resilience
- Adhesion
- Cohesion
- Color
- Chemical Inertness
- Impermeability
- Thermal Stability
- Biological Inertness
- Non-Absorptivity

Secondary Properties
- Abrasion Resistance
- Compressive Strength
- Cracking Resistance
- Dimensional Stability
- Fire Retardancy
- Humidity Resistance
- Impact Strength
- Indentation Resistance
- Mildew Resistance
- Moisture Impermeability
- Roughness
- Scratch Resistance
- Skid Resistance

A.9 Requirements for Exterior Accessories/Assemblies

Requirement 1
The Surface should provide protection of the substrate from the effects of maintenance, normal usage, weather and other exterior environmental factors.

Requirement 2
The Surface should not contribute to user hazard.

Requirement 3
The Surface should retain its designed decorative characteristics.

Requirement 4
Surface changes should not impair the functionality or operation of accessories and assemblies.

Primary Properties
- Hardness
- Resilience
- Adhesion
- Cohesion
- Color
- Chemical Inertness
- Impermeability
- Thermal Stability
- Biological Inertness
- Non-Absorptivity

Secondary Properties
- Abrasion Resistance
- Blister Resistance
- Chalking Resistance
- Color Retention
- Corrosion Resistance
- Cracking Resistance
- Dimensional Stability
- Elasticity
- Fire Retardancy
- Flexibility
- Gloss Retention
- Humidity Resistance
- Light Fastness
- Mildew Resistance
- Moisture Impermeability
- Stain Resistance
- Washability

Appendix B

The properties listed in Section 5.2 have been divided into two categories: primary and secondary.

Primary properties are defined here as fundamental physical, chemical or biological characteristics, expressed generically, such that they are not sub-definable in more general terms. Secondary properties are functions of primary properties and are definable in those terms. For example, abrasion resistance is a secondary property which may be defined in terms of the fundamental characteristics of hardness, cohesion and resilience. Secondary properties have commonly been referred to as engineering or design properties. Primary properties are more akin to the basic parameters of science.

A review of several "performance specifications" for buildings has indicated no attempt to subdivide properties into performance categories of primary or secondary levels.

The Interim Report on Performance Criteria, SUNY, lists major exposure categories for which materials must have various proprietary properties.

Publication 1, 1967, of the University Building System (URBS) of the University of California; the Contract Documents and Performance Specifications, July 1963,of the First California Commission on School Construction Systems (SCSD); the Schoolhouse Systems Project Program 2 (SSP) of the Florida State Department of Education and the Specifications for The First SEF Building System, Toronto, all contain specific requirement and criteria statements for material performance in areas such as washability, color, texture, resistance to scratch, water, humidity, chemicals, stains, impact, abrasion, heat, fire, etc.

The American National Standards Institute (ANSI) Standard A62.6-1969 entitled Classification for Properties and Performances of Coordinated Building Components and Systems is based on the International Council for Building Research (CIB) Master List of Properties for Building Materials and Products, CIB Report No. 3.

The properties listed in the standard are a mix of fundamental and proprietary characteristics categorized in broad classifications such as thermal, strength, mechanical, rheological, acoustic, optical, electrical, and biological properties as well as properties relating to the presence of water and fire. It also itemizes properties relating to health and safety, operation, working characteristics,

functionality and others. The standard does not describe relationships or functionalities of properties beyond the point of categorization.

The list of secondary properties in Section 10 was derived from a review and collation of Federal Test Method Standards Nos. 141a, 406 and 501a and ASTM Standards Parts 21 and 27. The primary properties were derived from an analysis of the secondary properties supplemented by technological judgement.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