

USE OF LIGHT IN SPECIFIC VISUAL TASKS OF
PERSONS 65 TO 74 YEARS OF AGE IN CLAY CENTER, KANSAS

by

28

ALICE LETTIE FREY

B. S., Kansas State University, 1955

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Family Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1969

Approved by:

Tessie Agan
Major Professor

ACKNOWLEDGMENTS

The writer expresses sincere appreciation to Miss Tessie Agan, Associate Professor, Department of Family Economics, for her guidance and encouragement throughout this study.

Gratitude is expressed to Mrs. Patty Annis, Assistant Professor of Family Economics for her valuable suggestions and willingness to help during the study. Appreciation is also expressed to Dr. Richard L. D. Morse, Professor and Head of the Department of Family Economics, and Dr. Dorothy Harrison for their constructive criticism of the manuscript.

TABLE OF CONTENTS

ACKNOWLEDGMENTS	ii
LIST OF TABLES	v
INTRODUCTION	1
REVIEW OF LITERATURE	3
Anatomy of the Eye	3
Ability to See	5
Visual Functions and Age	6
Senile Changes in the Eye	7
Rate of Dark Adaptation	9
Lighting Attributes	10
Definition of a Visual Task	10
Measuring Illumination	11
Quality of Illumination	12
Factors Affecting Quantity and Quality of Lighting	13
PROCEDURE	15
Selection of the Sample	15
The Interview Schedule	16
The Interview	17
RESULTS AND FINDINGS	19
Characteristics of Households	19
Household Composition	19
Age	20
Length of Residency and Home Ownership	20
Retirement and Employment	22
Income	26
Education	27
Eye Care and Use	28
Specific Visual Tasks Performed	30
Location of the Performance of Visual Tasks	32
Social Tasks	32
Service Tasks	37
Personal Tasks	38

Number and Type of Luminaires	39
Portable Luminaires	40
Installed Luminaires	42
Types of Luminaires Used for Visual Tasks	44
Portable Luminaires	45
Installed Luminaires	45
Number of Luminaires Used for Visual Tasks	49
Bulb Wattage	50
Incandescent Bulbs	50
Fluorescent Bulbs	52
Comparison of a Low and High Income Group	54
Quantity of Illumination	56
Footcandles Available for Specific Visual Tasks	56
Lumens Available by Rooms	61
Rooms Believed Most or Least Adequately Lighted	64
Factors Affecting Quantity and Quality of Illumination	65
Negative Characteristics of Luminaires	65
Reflectance Values of Room Surfaces	66
Cleaning of Luminaires	73
Electrical Outlets	73
Safety and Convenience Features	74
SUMMARY AND CONCLUSIONS	76
Summary	76
Conclusions	79
SELECTED BIBLIOGRAPHY	82
APPENDICES	84
PLATES	104

LIST OF TABLES

Table	Page
1. Household composition by sex	20
2. Length of residency by 50 households	21
3. Retirement status by sex	22
4. Previous occupation by sex	24
5. Present occupation by sex	25
6. Annual income by 50 households	27
7. Education by sex	28
8. Last time eyes were checked by sex	29
9. Specific visual tasks performed by 50 households	31
10. Rooms used for specific visual tasks by the 50 households..	33
11. Average number of luminaires per room	39
12. Number of portable luminaires in rooms by types	41
13. Number of installed luminaires in rooms by types	43
14. Number of portable luminaires used when performing specific visual tasks by type	46
15. Number of installed luminaires used when performing specific visual tasks by type	47
16. Number of luminaires used for performing specific visual tasks by 50 households	48
17. Number of incandescent bulbs in rooms by wattage	51
18. Number of fluorescent bulbs in rooms by wattage	53
19. Bulb wattage used by 16 households in a low income level of under \$2,999, and 8 households in a high income level of over \$7,000	55

Table	Page
20. Number of footcandle readings primarily from portable luminaires for specific visual tasks by rank order	59
21. Number of footcandle readings available primarily from installed luminaires for specific visual tasks by rank order	60
22. Number of lumens provided per square foot by lumens recommended per square foot in rooms	62
23. Number of rooms believed most or least adequately lighted by 50 households	65
24. Number of negative characteristics of portable luminaires affecting quality and quantity of illumination by rooms	67
25. Number of negative characteristics of installed luminaires affecting quality and quantity of illumination by rooms	68
26. Reflectance values of ceiling surfaces in rooms by rank order	70
27. Reflectance values of wall surfaces in rooms by rank order	71
28. Reflectance values of floor surfaces in rooms by rank order	72
29. Number of convenience electrical outlets in rooms by rank order	75

INTRODUCTION

Good vision is necessary to perform the tasks required for independence. Because of increased longevity the elderly need good vision for a longer length of time than formerly. In fact, according to Agan and Luchsinger (1965) the brain receives most of its stimuli from the eyes and nearly "85 percent of a person's activity depends on his eyes."

Older persons are dependent on their own initiative to develop worthwhile activities to fill their leisure time after retirement. Many of these visual tasks and activities such as reading, handiwork, food preparation and workshop tasks require good lighting for ease of performance. As far as is known inadequate lighting is not physically harmful and good lighting does not preserve eyesight. It does lessen eyestrain, fatigue, and frustration; and thus, improves efficiency and comfort while performing visual tasks.

It generally is believed that vision fails as age increases. Miles (1933) found declining visual and other capacities come with the process of aging. He stated that visual acuity gradually decreased from the twenties through the late sixties, with an additional drop in succeeding years. Work by Guth et al. (1956) showed that higher intensities of light are needed by older workers to secure the same degree of visibility as younger workers. But Weiss (1959) stated that not all impairment of sight can be overcome by increasing the intensity.

Good lighting attributes require that light is (1) enough for the task, (2) positioned correctly, (3) well distributed, (4) without strong contrast, and (5) free of glare for comfort of eyes.

While employed as an extension home economist in Clay County, Kansas it was observed that there were persons of all ages lacking many of the lighting attributes in their home. Among them were many older people who grew up in a generation when lighting was poor by today's standards, these standards having been raised over the years.

The number of people 65 years of age and older is rising as life expectancy increases. The percentage of the United States' population age 65 years and over has increased from 4.1 percent in 1900 to 9.4 percent in 1965, as reported by the U. S. Department of Health, Education and Welfare (1966). Life expectancy is presently 73.3 for females and 66.9 for males.

Clay County in relation to the State of Kansas and the nation is heavily populated with aged. Kansas, with 11 percent of its population 65 years and older, ranked 5th in the nation in 1960. Clay County had 18.7 percent of its population 65 years and older and ranked 7th in the state. Clay Center, its county seat and most important city, was even higher in density of aged, as it had 22 percent of its population in the aged group. One-half, 50.8 percent, of Clay County's aged population lived in Clay Center.

Little work has been done relative to lighting standards for the aged. Crouch (1965) stated the amount of light recommended for various tasks is based on the needs of young normal eyes, natural or

corrected 20/20 vision. He also pointed out that more work is needed to find out what the actual needs of the older person are in relation to the amount of illumination.

Therefore, it seemed pertinent to ascertain the use of light in specific visual tasks of persons 65 years and older in Clay Center, Kansas and to determine if aged people need an educational program to assist them to have better lighting in their homes. The objectives were to investigate (1) which specific visual tasks requiring lighting are performed by persons 65 years and older, (2) the level of lighting now being used for specific visual tasks, and (3) the facilities used in the provision of their light. Out of this investigation recommendations for improvement should develop.

REVIEW OF LITERATURE

The eye is a complex organism consisting of several parts, all essential for vision, but not totally understood. Seager (1963) stated:

Visual perception, with which we are vitally concerned, is the term applied to the complete process of "seeing", for it includes the focusing of the image of an adequately illuminated object on the retina of the eye, the conversion of this stimulus into nerve impulses, and the interpretation of these impulses in the brain, with a resultant modification of the behavior of the individual.

Anatomy of the Eye

The eye has a structure well adapted to the visual process. The eye, as described by Avery (1955) and Seagers (1965), is a spherically shaped, semi-elastic body. It is surrounded by the sclerotic coat,

a protective layer, mostly white and opaque, known as the white of the eye. At the center front it is transparent, and this part is known as the cornea. Behind the cornea is a cavity containing the aqueous humor, a clear liquid that serves as a refracting medium for light. Next is the iris, the colored portion of the eye, which has an opening in it known as the pupil. The iris, in response to different levels of illumination varies the size of the pupil that admits light to the lens. When light is dim the pupil increases in size allowing more light to enter, and when light is bright it decreases in size. The iris and the sclerotic coat are lined by a pigmented layer, the choroid, which prevents light from entering the eye except through the pupil. Behind the iris is located the lens, which by changing its focal length, focuses the image on the retina, at the back of the eye. The process of changing the shape of the lens so the eye can see near or far objects is known as accommodation. Accommodation is regulated by ciliary muscles. After the image is focused in the lens, further refraction of the light is accomplished by the vitreous humor, a jellylike transparent material in a larger cavity between the lens and the retina.

The retina, lining the large cavity, contains optic nerve endings and visual light sensitive receptor cells of which there are two types, cones and rods. The cones react to intense illumination and make possible perception of detail and color. The rods are sensitive to low levels of illumination, perceive light, but do not assist in discrimination of detail or color. The cones and rods are distributed

unevenly in the retina. A small, indented area in the center of the retina, the fovea, contains many cones. These provide clear vision and color discrimination if adequate light is available. The rest of the retina has cones and rods mixed, with cones decreasing from the fovea to the periphery of the retina. A nerve is provided for each cone, but one nerve serves many rods.

Ability to See

As a person develops visual perception, the eyes focus on a certain point. If the object is to be viewed in detail, the image must come to rest on the area of the retina that provides the clearest vision, that is, close to the fovea. An imaginary line from the object, through the center of the pupil, to the foveal area, is called the line of sight. The area of the retina on either side of the fovea provides peripheral vision that helps give an awareness of movement or objects outside the line of sight.

The function of the light sensitive receptors, cones and rods, generating nerve impulses in response to light is not understood completely. It is believed that light falling on receptor cells causes a chemical change within them, and results in the creation of nerve impulses. This change is known as a photochemical process, and one result is adaptation. Adaptation allows the eye to function in a wide range of illumination levels. This ability permits the eye to adapt from low to high levels of illumination in a short time, sometimes in

a minute, but perhaps longer, as much as 30 minutes from high to low levels of illumination.

Visual Functions and Age

Much research concerns visual functions, but little relates directly to visual functions as affected by age. Most of the studies reported were comparisons between the visual functions of the aged and youth. It is known that certain visual functions change with age, but not always why and how they change. Some of the studies associated with the effect of light and age on visual functions are reported here.

Weiss (1959) stated that with aging all sensory changes decline, but the amount varies with different senses. Visual changes occurring with age can be classified as neural or non-neural. Neural changes consist of a reduced nerve-cell population and cannot be compensated for by more illumination.

The effects of non-neural changes, such as smaller pupil openings, increased opacity and yellowing of the lens, and reduced visual acuity are believed to be compensated for, at least in the early stages of deterioration, by increasing the stimulation. The stimulant may be increased intensity or brightness of light, size of objects, and contrast of object with background. McFarland and Domey (1958) reported that at any age visual acuity decreases as illumination decreases.

Senile Changes in the Eye

One of the most obvious functional changes in vision with age is the impairment in ability to focus on near objects. This is caused by loss of strength or elasticity of the lens, previously defined as accommodation. With loss of elasticity of the lens, persons become farsighted. It should be noted that the decline of lens elasticity is gradual and begins during childhood. Up to a point the inability to focus can be corrected by means of convex lenses.

Accommodation is measured by diopters. Weiss (1959) reported that with age comes a decrease in maximum accommodation from 20 diopters at age 5 to 0.50 diopters at age 60, usually with no further decrease. Loss of accommodation can be compensated for partially by increasing illumination, especially for the aged as reported by Ferre and Rand (1933). That study showed that increasing the intensity of illumination increases the apparent diopters of accommodation. When intensity of illumination was increased, the aged showed greater improvement of vision than did the young.

Likewise, Roberts (1964), testing visual acuity of a group between the ages of 18 and 79, found a decline of visual acuity from the age of 45 years onward. Near vision tended to be more deficient than far vision, and the deficiency began earlier with near than far vision. The percentage of men with normal or better vision exceeded women throughout the age range studied.

The effect of increasing intensity of light on the visibility of print was studied by Guth et al. (1956). They showed that higher

intensities of light were needed by older subjects to secure the same degree of visibility as younger ones. This held true through successive age decades.

In addition to the loss of accommodation in the lens, there is further deterioration as the lens becomes less transparent. According to Weale (1965), this opacity occurs in the blue part of the spectrum with the result that the lens becomes more yellow with advancing age. Accompanying this change is a decrease in diameter of the pupil. These two changes affect the quantity and quality of light reaching the retina, and account for the rise in absolute threshold vision, that is, the point at which light is perceived, when the eye is completely dark adapted. The conclusion reached was that the retina of a 60 year old person receives about $1/3$ the white light that a 20 year old retina receives, whether light or dark adapted. If a blue light is used instead of a white light, even less light reaches the older retina.

There are two schools of thought as to whether the retina, regarded as a part of the brain, is, or is not, involved in senile changes. Weale (1965) reported strong evidence in support of the belief that this tissue is extremely resistant to senile change. It is believed further that some of the loss of acuity of vision in old age is not attributable to retinal decay, but to opacity of the lens and to bubbles that form there in the vitreous humor. With present knowledge, once formed, these bubbles cannot be removed and because of them light is not transmitted smoothly, but becomes scattered and blurry. No amount of light can compensate for the poor vision in this instance. In fact, more light,

creating more scattering and blurring, results in additional discomfort and loss of vision.

Rate of Dark Adaptation

The rate at which the eye adapts from light to dark is important at any age. It is measured by the time it takes to perceive a small amount of light, after exposure to much light. McFarland (1967) found that the rate of dark adaptation was inversely related to age. This is to say that as we age the amount or intensity of light constituting the threshold must be increased. McFarland and Fisher (1955) reported the threshold level of illumination had to be approximately doubled for each increase of 13 years of age.

Rate of adaptation as measured by a Hecht-Shlaer apparatus was reported by McFarland (1967). After two minutes the very young were almost five times more sensitive than most of the old, and after 40 minutes they were 240 times more sensitive than were most of the aged. The adaptation involves both rods and cone cells of the retina that are constantly changing from rod to cone vision and vice versa. Older people are known to be greatly handicapped under these conditions. An illustration of this is the operation of motor vehicles at night where light levels change frequently. Older persons finding their way around a dark house might find vision impaired by turning the light on, then off, and proceeding to walk from one room to another.

Lighting Attributes

Definition of a Visual Task

A visual task is defined by the Illuminating Engineering Society in the IES Lighting Handbook (1966) as "the sum total of all things that have to be seen at a given moment." The character of the visual task is constantly changing. At one moment it may be reading, and a few moments later it may be looking out the window.

The four important aspects of a visual task are its brightness, contrast, size, and time. An object is seen because it is a source of light or because it reflects light. How bright the task is influences the ease with which it is viewed. The greater the contrast of the task with its immediate background, the more easily the task is seen. For instance, a white object on a black background is seen easier than on a gray background. A larger object is seen easier than a small object. For example, large print is more readable than very small print.

Seeing is not an instantaneous process as there is a time lag in the photochemical process. More time is required to view small objects under low levels of illumination than under a higher level according to Seagers (1963).

All four of the aspects are part of the visual task, and a change in any one affects the ease of seeing the visual task. There are certain lighting attributes that are required to illuminate the visual tasks and make it possible for the task to be seen.

Lighting attributes require that there is sufficient light of good quality for the performance of visual tasks. In prescribing the quantity and quality of light for a visual environment, research in disciplines such as physiology, psychology, physics, engineering needs to be considered.

Measuring Illumination

Quantity of illumination usually is measured in footcandles. A footcandle describes the intensity of light falling on a surface. Recommended minimum footcandles suggested for specific visual tasks are listed in the IES Lighting Handbook of 1966. These recommendations (Appendix A) are based primarily on research of H. R. Blackwell (1959) at the University of Michigan. Most of the subjects for this research were college age students.

Tinker (1947) stated that recommended levels of illumination were higher than necessary, and that the trend was to specify extremely high intensities and then convince consumers that the higher levels of illumination improved vision. He believed that people should be informed as to what is adequate illumination and what is surplus.

The luminous intensity of a source is the luminous flux (the time rate of flow of light) radiated per unit solid angle. The lumen is the unit of source intensity. In their "Home Lighting Bulb Guide", General Electric gives the output of bulbs in approximate lumens, and makes recommendations for lighting installations in terms of lumens per square foot. The recommendations are 80 lumens for the living room and kitchen, 40 lumens for the dining room, 60 lumens for the bathroom, and 70 lumens for the bedrooms, laundry, and work-bench area.

Calculation of lumens per square foot for each room is done by totaling the approximate lumens for each bulb in the room and dividing by the square feet in the room. Comparison should then be made with recommendations of the "Home Lighting Bulb Guide".

Quality of Illumination

Quality of light is determined by the distribution of light on the task and in the area surrounding the task. Even though the quantity is normally adequate for the visual task, the light may not be properly distributed. When not properly distributed, glare may be the result. Glare is considered a sensation caused by light that enters the eye in such a way as to inhibit vision. It causes discomfort from eyestrain and fatigue. Glare is produced by too much light, too bright a source, undiffused light, reflected brightness from surfaces, and excessive contrasts. The ability to see in the presence of glare is related to the aging process, and Wolf (1964) showed that glare impairs vision more after than before age 40.

Light that is properly distributed is diffused. It comes from many directions and creates no visible shadows. Diffusion may be achieved by increasing the apparent area of the light source, such as frosting a light bulb, so the intense brightness of the filament is not seen. Rough or pebbly surface areas scatter the light more than smooth surfaces. The shape and texture of devices used for diffusion influences the distribution of the light.

Lighting for the visual task requires illumination on the task and in the immediate and general surroundings. Extreme differences of

illumination between task and surroundings cause adaptation in the eye as it moves from a high to low, or low to high level of illumination. On the other hand, the same level of illumination for the task and surroundings is not desirable. The same level of illumination is monotonous and vision is sharpened by some contrast. In addition the eyes are rested not only by looking from near to far, but are relieved by looking from an intensely lighted area to an area less intensely lighted. The general rule for light distribution is to have $1/10$ to $1/5$ as much general light as light on the task.

Factors Affecting Quantity and Quality of Lighting

The quality and quantity of light for a visual task is affected by the illuminating source, diffusion device, lampshade, and location of the luminaire. A luminaire is defined as the complete lighting unit such as a ceiling or wall fixtures, portable fixture, or a built-in unit.

Light is transmitted, absorbed, or reflected by objects. The surfaces near the luminaire will absorb some of the light, reflect some, particularly if smooth and shiny, and transmit light if it is translucent or transparent. Opaque materials prevent light transmission.

The quantity of light coming from the illuminating source is dependent upon the number of bulbs and their wattage, shape, type, and length of time used. Location of the luminaire in relation to the task greatly affects the quantity of illumination, because the footcandles decrease inversely as the square of the distance. That is, the farther the task is from the light source the less light there is available. The IES Lighting Handbook (1966) recommends that a table or small floor

luminaires be located 20 inches left or right of task center and 16 inches back from the center of the task. For a luminaire used on a desk they recommend it be placed 15 inches to the left (or right for left-handed person) of the task center and 12 inches back from the front edge of the desk top. In addition, IES (1953) recommends that a taller floor luminaire be positioned 15 inches left or right of task center and 26 inches back from the task center.

The reflectance values considered desirable for room surfaces were 60 to 90 percent for ceilings, 35 to 60 percent for walls, and 15 to 35 percent for floors as stated in the IES Handbook (1966). Lower percentages of reflectance cause loss of light for the task, whereas higher percentages reflect too much light causing discomfort to the eyes.

Lampshades that are opaque and dark absorb light. A light colored, translucent lampshade with a white or light lining allows more light for the task, but prevents seeing the light source. Lampshade size is important as it influences light distribution. For a visual task, a shade that is slightly larger at the bottom than at the top, and not extremely tall allows the light to spread over the task. When seated, the lower edge of a lampshade on a table luminaire should be at eye level.

Diffusion devices, scattering light in many directions, are desirable to prevent glare. When performing tasks for prolonged periods of time they are more necessary than for short periods. Devices used in portable luminaires are usually glass or plastic bowls and plastic or metal discs. Many portable luminaires have no diffusion device. This is

satisfactory only if the lampshade diffuses the light and the luminaire is used for short periods of time. For installed luminaires, the device used to shield the light source usually diffuses the light. These shields are frequently glass enclosed globes and plastic or glass panels and discs. Some shields diffuse light well and some poorly.

PROCEDURE

Clay Center, Kansas, was chosen for the study because of its high percentage of persons 65 years and older, and its proximity to Kansas State University. In addition, the writer was familiar with the town, having worked there as an extension home economist for nine years.

The purpose of this study was to determine if an educational program is needed in Clay Center, Kansas, for the aged population to improve lighting in their homes. If this program is needed, it is the wish of the writer to incorporate it into an extension home economics program. To determine if such a program is needed by the aged, data were obtained on (1) the visual tasks performed, (2) facilities for lighting, and (3) quantity of illumination available in the homes of persons 65 to 74 years of age.

Selection of the Sample

A sample representative of aged persons living in independent households was selected. The age range of 65 to 74 years was chosen, because persons in this range are financially better able to maintain their homes, be independent, engage in physical and other activities more than most persons 75 years of age and older.

The Clay Center assessor's roll books were used for identifying the population from which the sample was drawn. This was the latest and most accurate information available on names, addresses, and ages of residents of Clay Center.

In cases where the roll books showed a person of age 65 to 74 years living with a younger person, some value judgments were necessary to decide who was head of the household, and thus should be included in the sample. This question often was resolved by the county clerk checking the tax roll records, and the writer's own knowledge of the people. A total of 470 independent households were identified as having at least one person between the age 65 to 74 years. H. C. Fryer, a statistician from the Agricultural Experiment Station at Kansas State University, drew a simple random sample of 50 numbers, providing a 10.6 percent sample. Two alternate numbers, those immediately following the random number, were drawn for use if there were refusals, deaths, or other reasons for noncooperation.

The Interview Schedule

Personal interviews rather than mailed questionnaires were considered the better method to obtain the data. A three-page schedule (Appendix B) was developed to secure information to fulfill the objectives of the study.

The schedule was divided into four sections: (1) personal, (2) general, (3) safety, convenience, care, and (4) provisions for lighting of specified tasks.

The personal section included questions believed important for better interpretation of data concerning the length of residency, home ownership, composition of household, education, retirement, income, age and eye hygiene.

The questions under general were designed to provide some information from the respondents on their use and knowledge of lighting. These questions related to the rooms believed to be adequately lighted, how general light was used, how they watched TV, and their knowledge of light bulb wattage. The section on safety, convenience, and care pertained to their maintenance and use of lighting supplies.

Information, contained on one page, concerned luminaires and their characteristics, room reflectances, visual tasks performed, foot-candles available, and the respondents' judgment concerning adequacy of illumination. Additional pages were used as needed.

The Interview

A letter (Appendix C) was written to the selected persons explaining the study, asking their cooperation, and telling them the interviewer would be calling some time in the next few weeks. It was believed some rapport was established by the letter, since almost everyone interviewed knew or was at least familiar with the name of the interviewer. Of the original households contacted six refused, three were not at home during repeated calls, one had moved out of town, and two were deceased. Using the alternate random numbers drawn from the population it was possible to secure the 50 interviews.

A badge showing the interviewer's name and Kansas State University printed on it was worn for identification. The local Chamber of Commerce, police chief and the agricultural extension agents were notified that the study was being conducted within the city.

A specific time was not arranged in advance for the interview, but if the person appeared busy, a later appointment was made. At the beginning of each interview an explanation was given as to the purpose of the study, how the households were chosen, and that information would be kept confidential. Many of the persons drawn for the sample were more willing to cooperate after learning their name had been selected at random.

The investigator read the questions and wrote the answers on the schedule. For the question on income, respondents were handed 4 x 6 inch typed cards (Appendix D) listing the income brackets.

Three measurements were made during the interview; location of certain luminaires in relation to the task, surface reflectances, and footcandle readings. Location of the luminaires in relation to the task was measured by three devices. The devices were like a carpenter's square, and were used to determine if floor, table, and desk luminaires were located according to the recommendations of the Illuminating Engineer Society.

Room surface reflectances were estimated by a reflectance value chart in General Electric's pamphlet on "Light and Interior Finishes." Representative color chips were held against the room surfaces and the reflectance value of matching chips was recorded.

The footcandle readings were taken at night by the use of a Weston footcandle meter, Model 614, in the area and on the plane where

the respondent performed the visual task. If a luminaire provided light for several tasks, a reading was taken for each task. After the completion of all interviews, it was believed the footcandle meter was out of adjustment. The meter was returned to the factory for adjustment, and the footcandle readings were corrected according to the amount of error (Appendix E).

Data for the study were obtained by personal interviews in 50 households during September, October, and early November, 1967. Average length of interview depended on the number of luminaires and rooms, but lasted about one to one and a half hours. The return visit for taking footcandle readings lasted less than a half hour.

The data were analyzed and frequency tables made. It was anticipated that some relationship might be established between lighting and each of the following factors: home ownership, income, education and retirement status. After securing data, it appeared that subjects were extremely similar, and the only statistical analysis was on lighting and income.

RESULTS AND FINDINGS

Characteristics of Households

Household Composition

Of the 82 respondents interviewed, over two-thirds (68%) were husband and wife households and about one-fifth (21%) were women living alone (Table 1). Of the other nine (11%), one lived with her sister and the rest were husbands and wives having one other relative such as

an aunt, daughter, or grandson living with them. Of the 17 women living alone, 15 were widows.

TABLE 1.--Household composition by sex

Composition	Women		Men		All	
	Number	Percent	Number	Percent	Number	Percent
Couples alone	28	56	28	88	56	68
Couples with others in household	4	8	4	12	8	10
Living alone	17	34	0	0	17	21
Living with other adult	1	2	0	0	1	1
Total	50	100	32	100	82	100

Age

The selection of 50 households with at least one person between 65-74 years of age resulted in two-thirds (67%) of 82 respondents being in this age group. For the other one-third (33%), some spouses were under 65 or over 74 years of age. In several other instances the respondents had had a birthday and had become 75 after the sample was drawn, but prior to the time of the interview.

Length of Residency and Home Ownership

Mobility of families is common in our society, but elderly families are less mobile than the young. If a residency of ten years

is long, it could be said that these people interviewed for this study were old timers. Nearly two-fifths (38%) had resided in Clay Center 20 years or more, and another fourth (26%) had lived there 10 to 19 years (Table 2). The rest, over a third, had lived in Clay Center less than 10 years, and 10 percent had lived there only 5 years or less. These were among the families having to move because of the construction of Milford Reservoir and the expansion of Ft. Riley reservation.

They had moved within Clay Center more than they had moved into it. Only a fourth (24%) had lived at their present address 20 years or more. About a third (32%) had lived there 10-19 years. The same number (but perhaps not the same people) had lived in Clay Center 6-9 years. However, 18 percent had lived at the same address for 5 years or less compared to 10 percent residing in Clay Center for that length of time.

TABLE 2.--Length of residency by 50 households

Length of residency	Clay Center		Present address	
	Number	Percent	Number	Percent
Less than 2 years	3	6	3	6
2-5 years	2	4	6	12
6-9 years	13	26	13	26
10-19 years	13	26	16	32
20 years or more	<u>19</u>	<u>38</u>	<u>12</u>	<u>24</u>
Total	50	100	50	100

Home ownership must be an important value to these people as all said they owned their homes. This is a higher rate of home ownership for the elderly than the national average which is 71 percent. This high rate of home ownership is related to their low rate of mobility. Most of the homes were in excellent condition and about two-fifths (40%) were fairly new, one story houses. Many of the older homes had been remodeled and were quite modern in appearance.

Retirement and Employment

Age 65 is considered the time to retire by many businesses, industries, and organizations. Because of the age group selected for the study most were retired; however, some were still working full or part time.

TABLE 3.--Retirement status by sex

Status	Women	Men	All
	Number	Number	Number
Retired	<u>45</u>	<u>29</u>	<u>74</u>
Not working	37	19	56
Working part time	8	10	18
Not retired and working	<u>5</u>	<u>3</u>	<u>8</u>
Working full time	2	3	5
Working part time	<u>3</u>	<u>0</u>	<u>3</u>
Total	50	32	82

Previous occupation.--Of the 82 respondents, all 32 men had had an occupation, but 29 of the 50 women had never had any paid occupation (Table 4). Since Clay Center is located in a predominantly agricultural area most of the economic base is related to farming and farm business or industry. Over half the men or 17 said their previous occupation had been farming.

Sixteen men and women had been in jobs classified as skilled, semi-skilled, or unskilled (Table 4). The nine women so occupied had been employed in jobs such as seamstress and presser in a cleaning establishment, cook for organized group, housework, and baby sitting. The seven men in this category had been employed in occupations such as custodian, farm laborer, carpenter, and barber.

Eleven women and men had been engaged in professional and managerial occupations. Seven men had been employed in occupations such as managers of business, store owner, and four women had been employed in jobs such as store owners and school teachers.

Clerical and sales employment had occupied nine men and four women. Only one had been so occupied and was a bookkeeper. The eight women had been employed as clerks in stores and bookkeepers.

Present occupations.--Retirement did not create shifts in occupational status, but showed fewer people working. The total number of women not employed increased from 58 percent to 74 percent, and for men from 0 to 60 percent (Table 5).

The tendency was for noticeably fewer men to farm, two compared with 17. Skilled, semi-skilled, and unskilled workers remained the same

TABLE 4.--Previous occupation by sex

Type	Women		Men		All	
	Number	Percent	Number	Percent	Number	Percent
Farmer	0	0	17	53	17	21
Workers, skilled, semi, unskilled	9	18	7	22	16	20
Professional-managerial	4	8	7	22	11	13
Clerical-sales	8	16	1	3	9	11
Never employed	<u>29</u>	<u>58</u>	<u>0</u>	<u>0</u>	<u>29</u>	<u>35</u>
Total	50	100	32	100	82	100

TABLE 5.--Present occupation by sex

Type	Women		Men		All	
	Number	Percent	Number	Percent	Number	Percent
Farmers	0	0	2	6	2	2
Workers, skilled, semi, unskilled	9	18	7	22	16	20
Professional-managerial	0	0	3	9	3	4
Clerical-sales	4	8	0	0	4	5
Not employed	37	74	19	60	56	68
Unclassifiable	<u>0</u>	<u>0</u>	<u>1</u>	<u>3</u>	<u>1</u>	<u>1</u>
Total	50	100	32	32	82	100

as for previous occupations, nine women and seven men. Those employed in professional and managerial jobs dropped from 11 to three, all men. Clerical and sales employment decreased from nine to four, all women.

Income

Income of the retired is usually less than during their working years. The level of living observed for these people seemed to be greater than what people whose income had always been at this level could have obtained.

Incomes ranged from under \$3,000 to over \$7,000 (Table 6). Nearly one-third (34%) had annual incomes of \$3,000 or less. There were three households who said they did not pay any income tax. From other things they said, and because social security is not subject to income tax, it might be inferred that they also had incomes of less than \$3,000. If this were true, those two groups together accounted for nearly two-fifths (38%) having incomes of \$3,000 or less. The President's Council on Aging in 1963 regarded an income of \$3,000 or less for a two member family as the poverty level. However, the Current Population Reports in May, 1968, regarded the poverty level of nonfarm residents for a two member family with the male head 65 years and older, as \$1,975.

One-third (34%) had incomes of between \$3,000 to \$6,999. Eight households had incomes of \$7,000 or more. Six households said they did not know or refused to tell their incomes.

Even though this sample revealed quite a few in the low income group, most had nice appearing homes. In fact, one of those saying their

income was \$3,000 or less had a new home. Others in this group had new appearing or remodeled homes. This further emphasizes the value the respondents evidently placed on home ownership.

TABLE 6.--Annual income by 50 households

Income	Number	Percent
Under \$3,000	<u>19</u>	<u>38</u>
Paid no income tax	3	6
Under \$1,999	9	18
\$2,000 - \$2,999	7	14
Over \$3,000	<u>25</u>	<u>50</u>
\$3,000 - \$3,999	11	22
\$4,000 - \$4,999	2	4
\$5,000 - \$5,999	3	6
\$6,000 - \$6,999	1	2
\$7,000 and over	8	16
Didn't know or refused	<u>6</u>	<u>12</u>
Total	50	100

Education

During the time respondents were of school age, an education was not as important as today. The median educational level was the eighth grade or less (Table 7). Nearly 30 percent had completed or attended some high school, 15 percent had completed or attended some college and 5 percent had attended a trade school.

Women completed more years of education, with one-third (34%) attending or finishing high school compared to one-fourth (25%) of the men (Table 7). One-fifth (20%) of women, and only 6 percent of men attended or completed college. Three men and only one woman attended a trade school. Sixty percent of men as compared to 44 percent of women had only eight grades or less of schooling.

TABLE 7.--Education by sex

Level	Women		Men		All	
	Number	Percent	Number	Percent	Number	Percent
8th grade or less	22	44	19	60	41	50
Some high school	8	16	8	25	16	19
High school	9	18	0	0	9	11
Some college	8	16	1	3	9	11
College and beyond	2	4	1	3	3	4
Trade school	<u>1</u>	<u>2</u>	<u>3</u>	<u>9</u>	<u>4</u>	<u>5</u>
Total	50	100	32	100	82	100

Eye Care and Use

Since the study was concerned with visual tasks performed by the members of the households, several questions were asked relating to the eyes. In reply to the question about wearing glasses, 81 of the 82 respondents indicated they did wear glasses when doing any task, and the other respondent said she usually wore them.

Eye care seemed of some importance to them, as shown by their eye check-up schedules. About one-third (36%) had a check-up within the year and one-fifth (20%) within the two years prior to the interview (Table 8).

Some did not seem as concerned or believe it was as important to have eyes checked. One-fourth (24%) had not had their eyes checked for four years or longer, and one-sixth (16%) had their last check-up between two and three years prior to the interview (Table 8). There was little difference between women and men in percentage distribution of check-ups.

In reply to the question, does your employment require close or partially close use of your eyes, five answered "Yes," 11 answered "Partial," and ten answered "No."

TABLE 8.--Last time eyes were checked by sex

	Women		Men		All	
	Number	Percent	Number	Percent	Number	Percent
Within the last year	18	36	11	34	29	36
1-2 years	12	24	8	25	20	24
2-3 years	9	18	4	13	13	16
4 or more years	<u>11</u>	<u>22</u>	<u>9</u>	<u>28</u>	<u>20</u>	<u>24</u>
Total	50	100	32	100	82	100

Specific Visual Task Performed

Activities performed in these households for which illumination recommendations are made for specific visual tasks are divided into three categories: social, service, and personal. Most of the social tasks were considered as leisure time activities while the service tasks included activities necessary to everyday living. There were a few borderline cases in which possibly some machine sewing and workshop tasks might have been social tasks, and some hand sewing such as mending might have been a service task.

Reading and watching TV proved to be the most popular social activities, with all doing some reading and 94 percent watching TV (Table 9). Letter writing was mentioned by 68 percent. Nearly two-thirds (60%) did some type of hand sewing, such as mending, hemming, or other similar tasks. Crocheting, embroidery, knitting and like tasks were included under handiwork, and someone in nearly one-half (48%) of the households found pleasure in this task. About one-third (34%) participated in table games, cards most frequently. Other visual tasks mentioned in decreasing order were playing the piano and organ, 14 percent; hobbies such as painting, coin collecting, and making decorations, 14 percent; crossword puzzles, 12 percent; and typing, 8 percent.

Service tasks performed by all the households included those related to food preparation, sink and range activities (Table 9). Ironing was done by 84 percent, while laundry was done in the home by only 70 percent as several used coin operated laundries. Nearly two-thirds

TABLE 9.--Specific visual tasks performed by 50 households

Tasks	Number	Percent
<u>Social tasks</u>		
Reading	50	100
Watching TV	47	94
Letter writing	34	68
Hand sewing	30	60
Handiwork	24	48
Playing table games	17	34
Hobbies	7	14
Playing piano or organ	7	14
Working crossword puzzles	6	12
Typing	4	8
<u>Service tasks</u>		
Food preparation	50	100
Sink activities	50	100
Range activities	50	100
Ironing	42	84
Laundry	35	70
Machine sewing	31	62
Record keeping	20	40
Food preservation	20	40
Workshop tasks	10	20
Cut out fabric	8	16
<u>Personal tasks</u>		
Grooming and make-up	47	94
Shaving	33	66

(62%) did some machine sewing. Two-fifths (40%) kept records and the same proportion preserved some food. Workshop tasks and cutting out fabric were done to a lesser extent, 20 and 16 percent, respectively. The personal tasks of grooming and make-up were performed by 94 percent of the household while 66 percent shaved.

Location of the Performance of Visual Tasks

The extent to which rooms were used for specific visual tasks was the basis for recommendation for illumination. If a visual task was performed, the rooms in which it was done were classified as to whether the task was predominantly done there, less frequently done there, or done in other rooms occasionally. The social tasks were predominantly performed in the living and living-dining rooms, service tasks in the kitchen and kitchen-dining rooms, and the personal tasks in the bathrooms (Table 10).

Social Tasks

Every room in the house, except the bath, was used for reading. Reading was done in the living and living-dining room by 84 percent of the households (Table 10). It was done less frequently in the bedroom and dining room, 38 and 20 percent, respectively. Other rooms used occasionally for reading were the kitchen and kitchen-dining, 12 percent; den, 8 percent; family and family-dining, 4 percent; and basement, utility and other rooms, 2 percent each.

Watching TV by 70 percent of the households was done in the living and living-dining room (Table 10). Six percent of the households

TABLE 10.--Rooms^a used for specific visual tasks by the 50 households

Tasks	Predominantly			Less frequently			Occasionally		
	Rooms	Number	Percent	Rooms	Number	Percent	Rooms	Number	Percent
<u>Social tasks</u>									
Reading	L,L-D	42	84	BR	19	38	K,K-D	6	12
				DR	10	20	Den	4	8
							F,F-D	2	4
							Base and Gar	1	2
							Ut and other	1	2
Watch TV	L,L-D	35	70	DR	3	6	F,F-D	2	4
							Den	1	2
							Base and Gar	1	2
							K,K-D	1	2
Handiwork	L,L-D	22	44	DR	5	10	BR	2	4
							F,F-D	1	2
							Den	1	2
Hand sewing	L,L-D	18	36	DR	6	12	K,K-D	3	6
				BR	5	10	F,F-D	1	2
							Base and Gar	1	2
Playing table games	L,L-D	12	24	DR	3	6	BR	1	2
				K,K-D	3	6			
Playing piano and organ	L,L-D	6	12	BR	1	2	-	-	-
				F,F-D	1	2	-	-	-
Working cross-word puzzles	L,L-D	5	10	DR	1	2	-	-	-

TABLE 10.--(continued)

Tasks	Predominantly			Less frequently			Occasionally		
	Rooms	Number	Percent	Rooms	Number	Percent	Rooms	Number	Percent
Letter writing	K,K-D	16	32	DR	8	16	Den	1	2
				L,L-D	7	14	Ut and other	1	2
				BR	6	12	-	-	-
Typing	K,K-D	3	6	BR	2	4	-	-	-
Hobbies	K,K-D	3	6	Ut and other	1	2	-	-	-
	Base and Gar	3	6	-	-	-	-	-	-
<u>Service tasks</u>									
Food preparation	K,K-D	50	100	-	-	-	-	-	-
Range activities	K,K-D	50	100	-	-	-	-	-	-
Sink activities	K,K-D	50	96	-	-	-	-	-	-
Ironing	K,K-D	17	34	Base and Gar	10	20	L,L-D	4	8
				DR	7	14	Ut and other	4	8
				BR	6	12	F,F-D	1	2
Food preservation	K,K-D	16	32	Base and Gar	4	8	-	-	-
Record keeping	K,K-D	9	18	L,L-D	5	10	DR	3	6
				BR	4	8	Den	2	4
				-	-	-	Ut and other	1	2
Cut out fabric	K,K-D	5	10	DR	2	4	Base and Gar	1	2

TABLE 10.--(continued)

Tasks	Predominantly			Less frequently			Occasionally		
	Rooms	Number	Percent	Rooms	Number	Percent	Rooms	Number	Percent
Machine sewing	BR	13	26	K,K-D	6	12	L,L-D	3	6
				Ut and other	5	10	DR	3	6
				Base and Gar	4	8	F,F-D	1	2
Laundry	Base and Gar	20	40	Ut and other	9	18	Bath	1	2
				K,K-D	5	10	-	-	-
Workshop tasks	Base and Gar	9	18				Gar	1	2
<u>Personal tasks</u>									
Grooming	Bath	46	92	BR	22	44	K,K-D	1	2
Shaving	Bath	31	62	BR	1	2	-	-	-
				Ut and other	1	2	-	-	-

^a Room abbreviation used for this table and hereafter are L,L-D for living and living-dining room; DR for dining room, F,F-D for family and family-dining room; K,K-D for kitchen and kitchen-dining room; Ut and other for utility and other rooms such as porches, hall, and pantry; Base and Gar for basement and garage; and BR for bedroom.

used the dining room, while the family and family-dining room, den, kitchen and kitchen-dining, and basement were used occasionally by 4 percent or less.

In almost one-half (44%) of households, handiwork was done in the living and living-dining room, and by 10 percent in the dining room. The bedroom, family and family-dining, and den were used occasionally by 4 percent or less.

Over one-third (36%) of the households did hand sewing in the living, living-dining room, 12 percent did it less frequently in the dining room and 10 percent in the bedroom. Six percent or less occasionally used the kitchen and kitchen-dining room, family, family-dining room and basement.

Playing table games was done in the living and living-dining room by one-fourth (24%) of the households, and less frequently in the dining room and kitchen and kitchen-dining by 6 percent. One person played solitaire in the bedroom.

Playing the piano and organ by 12 percent of the households, and working crossword puzzles by 10 percent was done predominantly in the living and living-dining room. Two percent played the piano or organ in the bedroom and family and family-dining room.

Letter writing was done by almost one-third (32%) of the households in the kitchen and kitchen-dining room, and less frequently by 16 percent in dining room, by 14 percent in living and living-dining room, and by 15 percent in the bedroom. Two percent of the households occasionally used the den and utility or other rooms (Table 10).

Typing was done by only 6 percent of the households in the kitchen and kitchen-dining room. Hobbies were performed in the kitchen and kitchen-dining room and in the basement by 6 percent of households. Two percent occasionally used the utility and other rooms.

Service Tasks

Food preparation, range and sink activities were performed in the kitchen and kitchen-dining room by all households, whereas 4 percent also did some sink tasks in the basement when having a large family gathering. Food preservation was done predominantly in the kitchen and kitchen-dining by nearly one-third (32%) of households, and less frequently in the basement of 8 percent of the households.

Ironing was done in the kitchen and kitchen-dining room by one-third (34%) of households. Rooms less frequently used were the basement by one-fifth (20%), the dining room by 14 percent, and the bedroom by 12 percent. Other rooms occasionally used by 8 percent or less of households were the living and living-dining, utility and other, and family and family-dining room. Only two rooms, the den and bathroom, were not used for ironing.

Record keeping and cutting out fabrics were done in rooms having desired table or counter space for working. Record keeping was done in the kitchen and kitchen-dining room by 18 percent of households, and less frequently in the living and living-dining room by 10 percent and in the bedroom by 8 percent. Occasionally 6 percent or less of the households used the dining room and utility and other rooms.

Cutting out fabric was done in the kitchen, kitchen-dining room by 10 percent of the households, less frequently in the dining room by 4 percent, and occasionally in the basement by 2 percent (Table 10).

Machine sewing was done in many rooms of the house with the predominant room used being the bedroom by one-fourth (26%) of the households. Rooms less frequently used were the kitchen and kitchen-dining room by 12 percent, the utility and other rooms by 10 percent, and the basement by 8 percent. The rooms used occasionally for this activity by 6 percent or less of the households were the living and living-dining, dining, and family and family-dining rooms.

Two-fifths (40%) of the households did the laundry in the basement. Less frequently, about one-fifth (18%) used the utility and 10 percent used the kitchen and kitchen-dining room. The bathroom was used occasionally by 2 percent of the households.

Workshop tasks were performed in the basement by nearly one-fifth (18%) of households while the garage was used by 2 percent of the households.

Personal Tasks

Grooming by 92 percent of the households and shaving by 62 percent, were done predominantly in the bathroom. The room less frequently used for grooming was the bedroom by 44 percent. Two percent of the households occasionally used the kitchen and kitchen-dining room for grooming and the bedroom and utility and other rooms for shaving.

Number and Type of Luminaires

In 326 rooms used for specific visual tasks in the 50 households, there were 842 luminaires, or an average of 2.6 luminaires per room (Table 11). The living and living-dining and family and family-dining rooms averaged about 3.5 luminaires per room; kitchen and kitchen-dining rooms, 2.8 luminaires per room; and bedrooms, 2.2 luminaires per room. The basements had the most luminaires per room with an average of about five, but the basements were usually the full size of the house and not divided into rooms. Luminaires ranged from five in a small five room house, to 38 in a seven room house with a full basement partitioned into three rooms.

TABLE 11.--Average number of luminaires per room

Room	Number of rooms	Number of luminaires	Average
L,L-D	52	181	3.5
DR	24	44	1.8
Den	4	10	2.5
F,F-D	2	7	3.5
K,K-D	50	143	2.8
Ut and other	15	18	1.2
Base and Gar	28	141	5.0
BR	98	216	2.2
Bath	53	82	1.5
Total	326	842	2.6

Portable Luminaires

Of the 842 luminaires (Table 11), 300 (26%) were portable (Table 12). Almost half (47%) of these 300 portable luminaires were in the living, living-dining rooms, and about two-fifths (39%) were in the bedrooms. Only one room, the bath, did not have a portable luminaire.

A total of 107 luminaires, slightly over one-third (36%) of the 300, were table luminaires. Over one-half of these, 68 luminaires, were in the living, living-dining rooms, but one living room did not have any portable luminaire. About one-fourth, 24 luminaires, were in the bedrooms and the remaining were in the dining rooms, basements and garage, dens and kitchen and kitchen-dining rooms.

Of the 300 portable luminaires, 70 (23%) were floor luminaires. Almost three-fourths of these, 49 luminaires, were in the living and living-dining rooms. The remaining were in the bedrooms, dining rooms, dens and family and family-dining rooms.

Fifty-two (17%) of the portable luminaires were dresser luminaires. All of these were in the bedroom, except for two in the basement.

There were 20 pole luminaires with 15 of these being located in the living and living-dining rooms. One pole luminaire was located in each of the following rooms: dining room, den, family and family-dining, basement and garage, and bedroom.

Of the 16 wall pin-up luminaires, nine were in the bedroom. There were two each in the living and living-dining rooms, dining rooms, and basements and garage, with one being found in the kitchen and kitchen-dining rooms.

TABLE 12.--Number of portable luminaires in rooms by types

Room	Table	Floor	Dresser	Pole	Wall pin-up	Bed	Other	Total
L,L-D	68	49	-	15	2	-	6	140
DR	6	5	-	1	2	-	-	14
Den	3	3	-	1	-	-	1	8
F,F-D	-	1	-	1	-	-	-	2
K,K-D	1	-	-	-	1	-	-	2
Ut and other	-	-	-	-	-	-	1	1
Base and Gar	5	3	2	11	2	-	2	15
BR	24	9	50	1	9	14	11	118
Bath	-	-	-	-	-	-	-	-
Total	107	70	52	20	16	14	21	300
Percent	36	23	17	7	5	5	7	100

The 14 bed luminaires were located in bedrooms. Of the 21 "Other" luminaires, 11 were in bedrooms, six in living and living-dining rooms, and five were in the dens, utility and other rooms, and the basements.

Installed Luminaires

Of the total 842 luminaires (Table 11) in the 50 households, 542 (64%) were installed luminaires (Table 13). Over a fourth, 141 of the installed luminaires, were located in the kitchen and kitchen-dining rooms, and nearly another fourth, 126 luminaires, were found in the basements and garage. There were 98 installed luminaires in bedrooms and 82 in bathrooms. The living and living dining room was the site of 41, but 15 of these rooms had no installed luminaires.

The types of installed luminaires were ceiling, ceiling drop cord, recessed ceiling, wall, ceiling or wall pull-down, and range or hood luminaires. Of the 542 installed luminaires, one-half were ceiling luminaires. About a third each of these was located in the bedrooms and the kitchen and kitchen-dining rooms. Other rooms having ceiling luminaires were the dining rooms, bathrooms, basements and garage, and living and living-dining rooms, and to a lesser extent the utility and other rooms. There were no ceiling luminaires in the dens.

There were 112 ceiling drop cord luminaires, and most of these were in the basements and garage, usually unshielded, bare bulbs. The rest were found in the bathrooms, bedrooms, kitchen and kitchen-dining rooms, dining rooms, and utility and other rooms.

TABLE 13.--Number of installed luminaires in rooms by types

Room	Ceiling	Ceiling dropcord	Recessed ceiling	Wall	Pull down wall or ceiling	Range or hood	Total
L,L-D	31	-	1	5	4	-	41
Dr	21	1	1	3	4	-	30
Den	-	-	1	-	1	-	2
F,F-D	2	-	-	2	1	-	5
K,K-D	80	2	6	15	9	29	141
Ut and other	10	1	1	5	-	-	17
Base and Gar	24	100	2	-	-	-	126
BR	80	3	8	7	-	-	98
Bath	22	5	4	51	-	-	82
Total	270	112	24	88	19	29	542
Percent	50	20	5	16	4	5	100

The 24 recessed ceiling luminaires were scattered throughout the house, with the family and family-dining room the only room not having this type of luminaire. Eight recessed luminaires were located in bedrooms, six in the kitchen and kitchen-dining rooms, and four in the bathrooms.

There were 88 wall luminaires accounting for one-sixth (16%) of the total installed luminaires. Fifty-one were located in the bathrooms and 15 in the kitchen and kitchen-dining rooms. The only rooms not having wall luminaires were the dens, basements and garage.

Only 19 wall or ceiling pull-down fixtures were found in the 50 households. About one-half of these were in the kitchen and kitchen-dining rooms and four each were in the living and living-dining and dining rooms. One each was found in the family and family-dining room and the den.

All of the range and hood luminaires were in the kitchen, kitchen-dining rooms.

Types of Luminaires Used for Visual Tasks

The types of luminaires used for the various visual tasks are shown by Tables 15 and 16. The floor or table luminaire was used more often than were all the other luminaires together. Many luminaires were used for more than one task.

Portable Luminaires

The portable luminaires were used primarily for the social tasks rather than service or personal tasks (Table 14). The table and pole luminaires provided illumination for reading, watching TV, and handiwork more often than for other social tasks. The floor luminaires were used frequently for these same tasks, plus hand sewing and playing table games. The wall pin-up, gooseneck, and other luminaires used for social visual tasks mainly provided illumination for reading.

Portable luminaires used when performing service tasks were for ironing, machine sewing, and record keeping. Many of these luminaires were providing supplementary light in addition to the machine light and general room illumination.

Of the few portable luminaires used for grooming, the dresser luminaire was used most often.

Installed Luminaires

The installed luminaires provided illumination mainly for service and personal visual tasks instead of social tasks (Table 15). Ceiling luminaires were used for sink and range activities, food preparation, ironing, machine sewing, and grooming more than the other service tasks. The ceiling drop cord luminaire found most often in the basements, provided light for the laundry and workshop tasks. Recessed ceiling luminaires gave light for sink tasks, food preparation, machine sewing, and ironing more than other service and personal tasks. Range and hood luminaires, of course, were used for range activities. Most of the wall luminaires were used for grooming and shaving.

TABLE 14.--Number of portable luminaires used when performing specific visual tasks by type

Task	Table	Floor	Dresser	Pole	Wall pin-up	Gooseneck	Other
<u>Social tasks</u>							
Reading	49	36	1	12	5	6	6
Watching TV	13	16	-	5	1	-	3
Letter writing	6	8	1	-	-	1	2
Hand sewing	9	11	-	3	1	-	-
Handiwork	12	10	-	4	2	1	-
Playing table games	2	11	-	1	-	-	1
Hobbies	2	-	-	-	-	-	-
Playing piano or organ	-	3	-	3	-	-	1
Working crossword puzzles	3	2	-	1	-	-	-
Typing	1	1	-	-	-	-	-
<u>Service tasks</u>							
Food preparation	-	-	-	-	1	-	-
Sink activities	-	-	-	-	-	-	-
Range activities	-	-	-	-	1	-	-
Ironing	1	5	1	-	1	1	-
Laundry	1	-	1	-	-	-	-
Machine sewing	2	9	-	-	1	3	1
Record keeping	4	5	1	-	-	-	1
Food preservation	-	-	-	-	1	-	-
Workshop tasks	-	-	-	-	-	-	-
Cut out fabric	-	-	-	-	-	-	-
<u>Personal tasks</u>							
Grooming	-	1	11	-	3	-	-
Shaving	-	-	-	-	-	-	-

TABLE 15.--Number of installed luminaires used when performing specific visual tasks by types

Task	Ceiling	Drop cord ceiling	Recessed ceiling	Wall	Pull down wall or ceiling	Range or hood
<u>Social tasks</u>						
Reading	10	1	1	8	4	-
Watching TV	5	-	1	1	1	-
Letter writing	14	-	1	2	7	-
Hand sewing	8	1	1	-	2	-
Handiwork	3	-	-	2	1	-
Playing table games	6	-	-	-	5	-
Hobbies	4	3	-	-	1	-
Playing piano or organ	-	-	1	-	-	-
Working crossword puzzles	-	-	-	-	-	-
Typing	1	-	1	-	-	-
<u>Service tasks</u>						
Food preparation	52	2	2	5	-	4
Sink activities	46	2	4	5	-	-
Range activities	19	1	2	3	-	27
Ironing	28	5	5	3	2	-
Laundry	15	22	1	5	-	-
Machine sewing	24	2	4	1	-	-
Record keeping	10	-	2	1	4	-
Food preservation	15	5	1	-	-	-
Workshop tasks	2	16	-	-	-	-
Cut out fabric	5	1	-	-	2	-
<u>Personal tasks</u>						
Grooming	23	1	3	39	-	-
Shaving	10	5	-	25	-	-

Installed luminaires often provided supplementary illumination for social visual tasks, but not always. In reply to the question, "Do you use general (installed) luminaires with local lighting when performing specific visual tasks?" 30 respondents answered "No", 13 answered "Yes", and seven answered "Usually".

Many said the only time the ceiling luminaire in the living and living-dining room was turned on was when guests arrived for the evening.

Ceiling luminaires, when providing illumination for social tasks, were used for letter writing, hand sewing and reading. They were used less often for watching TV, playing table games, handiwork and hobbies. Wall luminaires were used mostly for reading, whereas the pull-down luminaires provided light for reading, playing table games and letter writing.

Number of Luminaires Used for Visual Tasks

The number of luminaires used for the various specific visual tasks by all 50 households ranged from four for typing to 139 for reading (Table 16). For reading most households used two or three luminaires, but five used only one, and 11 used four or more.

For the social tasks of watching TV, letter writing, hand sewing, and handiwork, nearly all used only one luminaire, and a few used two or three. When other social tasks were done such as hobbies, playing piano or organ, working puzzles and typing, the use of more than one luminaire was rare. Five households did not use any luminaires to watch TV.

TABLE 16.--Number of luminaires used for performing specific visual tasks by 50 households

Tasks	Household	Total luminaires	Number of luminaires by households					
			1	2	3	4	5 or more	
<u>Social tasks</u>								
Reading	50	139	5	20	14	7	4	
Watching TV	42	48	37	4	1	-	-	
Writing letters	34	41	29	3	2	-	-	
Hand sewing	28	35	22	5	1	-	-	
Handiwork	24	35	16	8	1	-	-	
Playing table games	17	26	11	4	1	1	-	
Hobbies	7	10	5	1	1	-	-	
Playing piano, organ	7	8	6	1	-	-	-	
Working crossword puzzles	6	7	5	1	-	-	-	
Typing	3	4	2	1	-	-	-	
<u>Service tasks</u>								
Food preparation	50	66	34	16	-	-	-	
Sink tasks	50	55	45	5	-	-	-	
Range tasks	39	45	33	6	-	-	-	
Ironing	41	52	30	11	-	-	-	
Laundry	35	36	34	1	-	-	-	
Machine sewing	31	43	20	10	1	-	-	
Food preservation	19	22	16	3	-	-	-	
Record keeping	19	27	14	2	2	1	-	
Workshop tasks	10	18	6	2	1	-	1	
Cut out fabric	8	8	8	-	-	-	-	
<u>Personal tasks</u>								
Grooming	58	81	39	15	4	-	-	
Shaving	34	41	27	7	-	-	-	

The luminaires used for service tasks by all households, ranged from eight for cutting out fabric to 66 for food preparation. Again, the most common number used per household was one. More households, as many as 16 for food preparation, used two luminaires for the service tasks. A few households used three or more luminaires for machine sewing, record keeping, and workshop tasks.

For the personal tasks, 81 luminaires were used for grooming and 41 for shaving. Most households used one luminaire for these tasks, but there were as many as 22 households using two, and four used three.

Bulb Wattage

Incandescent Bulbs

The type of bulb and its wattage used is an indicant of the amount of illumination produced. Usually the higher wattages produce higher illumination. There were 1067 incandescent bulbs of which 61 were three-way bulbs in the 50 households (Table 17). Of the 1006 one-way bulbs, over one-half (53%) were 60 watts or less, one-third (33%) were 60 watts, and 11 percent were 40 watt bulbs. Twenty-one percent of the bulbs were 75 watts and 24 percent were 100 watts. Only 2 percent were 150 watts or larger.

Slightly over a half of all incandescent bulbs were found in living and living-dining rooms and bedrooms, the rooms also having the largest number of luminaires. The 60 watt or less size bulbs were found primarily in the bedrooms, but quite a few were used in the living and living-dining rooms. The 40 watt bulbs were used mainly in the bathrooms,

TABLE 17. Number of incandescent bulbs in rooms by wattage

Wattage	L,L-D	DR	F,F-D	Den	K,K-D	Ut and other	Base and Gar	BR	Bath	Total	Per-cent
25 watt or less	22	10	-	-	4	-	3	21	6	66	7
40 watt	24	4	1	-	8	2	17	28	31	115	11
50 watt	11	3	5	-	-	-	-	1	-	20	2
60 watt	82	32	1	4	40	6	20	123	24	332	33
75 watt	46	21	2	3	34	5	27	56	19	213	21
100 watt	43	16	5	9	43	4	60	36	21	237	24
150 watt	5	-	-	-	2	-	12	-	-	19	2
200 watt	-	-	1	-	-	-	2	-	-	3	-
300 watt	-	-	-	-	-	-	1	-	-	1	-
Total	233	86	15	16	131	17	142	265	101	1006	100
Three-way bulbs											
30/70/100 watt	9	-	-	-	-	-	-	1	-	10	16
50/100/150 watt	23	-	-	-	-	-	-	1	-	24	39
50/200/250 watt	2	-	-	-	-	-	-	-	2	4	7
100/200/300 watt	19	-	-	2	-	-	1	1	-	23	38
Total	53	-	-	2	-	-	1	3	2	61	100

bedrooms, and living and living-dining rooms. The bulbs larger than 60 watts were found mainly in the living and living-dining rooms, kitchen and kitchen-dining rooms, basements, and bedrooms. The 150 watt or larger bulbs were used in the basements, with a few used in the living and living-dining rooms.

Of the 60 three-way incandescent bulbs, nearly two-fifths (39%) were 50/100/150 watts and another two-fifths (38%) were 100/200/250 watts. One-sixth (16%) were 30/70/100 watts and the remaining were 50/200/250 watts. The three-way bulbs might be expected to be found in the living and living-dining rooms, and 53 percent were used in these rooms. Other rooms having three-way bulbs were the basements, dens, bathrooms, and bedrooms.

Fluorescent Bulbs

Fluorescent bulbs were used to only a minor extent, but they are considered to give a pleasant even illumination. There were 64 fluorescent bulbs of which 48 were used in the kitchen and kitchen-dining rooms (Table 18). Most of these were installed as part of the range. The remaining fluorescent bulbs were found in the bathrooms, basements and garage, living and living-dining rooms, dining rooms, and utility and other rooms.

Of the 64 fluorescent bulbs, two-fifths (41%) were 20 watts, and there was one-sixth (17%) each of the 14 and 15 watt bulbs. One-fifth (20%) were 30 or 40 watts. Three households had circline fluorescent bulbs of 32 and 40 watts.

TABLE 18. Number of fluorescent bulbs in rooms by wattage

Wattage	L,L-D	DR	F,F-D	Den	K,K-D	Ut and other	Base and Gar	BR	Bath	Total	Per-cent
14 watt	-	-	-	-	7	-	-	-	4	11	17
15 watt	-	-	-	-	9	-	1	-	1	11	17
20 watt	1	2	-	-	21	-	1	-	1	26	41
30 watt	-	-	-	-	6	-	-	-	-	6	9
40 watt	-	-	-	-	3	1	3	-	-	7	11
Circline											
32 watt	1	-	-	-	1	-	-	-	-	2	3
40 watt	-	-	-	-	1	-	-	-	-	1	2
Total	2	2	-	-	48	1	5	-	6	64	100

Comparison of a Low and High Income Group

It was believed that income might be a factor in the type and size of bulbs used. A comparison was made of bulb usage by wattage between the 16 households in the low income group of \$2,999 and under and the 8 in the high income group of \$7,000 and over.

Income was associated with the choice of bulb wattage. Sixty-four percent of incandescent bulbs used by the low income group were 60 watts or less as compared to 42 percent for the high income group (Table 19). The most common size bulb used by the high income group was 100 watts. Of the fluorescent bulbs, 90 percent of those used by the low income group were 20 watts or less as compared to 63 percent by the high income group.

The statistical analyses, the t-tests, were applied to the data for the two extreme income levels. The hypothesis that there is no significant difference between income level and wattage of incandescent bulbs used, was rejected at the 0.01 percent level of significance (Appendix F). It was concluded that those at the higher level furnished their homes with a greater wattage of light than those at the lower economic level.

The hypothesis that there is no significant difference between income level and wattage of fluorescent bulbs used, was accepted even at the 0.10 percent level of significance. It was concluded that economic levels are not associated with differences in fluorescent wattage bulbs used.

TABLE 19.--Bulb wattage used by 16 households in a low income level of under \$2,999, and 8 households in a high income level of over \$7,000

Bulb wattage	Under \$2,999		Over \$7,000	
	Number	Percent	Number	Percent
Incandescent				
25 watt or less	24	9	17	7
40 watt	39	15	29	12
50 watt	14	5	10	4
60 watt	93	35	48	19
75 watt	42	16	49	19
100 watt	31	12	72	29
150 watt	2	1	8	3
200 watt	-	-	3	1
300 watt	-	-	-	-
30/70/100 watt	4	2	-	-
50/100/150 watt	8	3	4	2
50/200/300 watt	1	-	1	-
100/200/300 watt	4	2	10	4
Total	262	100	251	100
Fluorescent				
14 watt	2	11	5	21
15 watt	4	20	3	13
20 watt	11	58	7	29
30 watt	2	10	2	8
40 watt	-	-	4	17
Circline				
32 watt	-	-	1	4
40 watt	-	-	2	8
Total	19	100	24	100

Quantity of Illumination

When considering the quantity of illumination necessary for any task the desired discrimination of detail plays an important role. Also, the requirements for every individual's eyes are different, and require different quantities of illumination. Recommendations are based on the average young person, but the average person does not exist.

The quantity of illumination in the 50 households was determined by the footcandle readings. According to the recommendations, the quantity of illumination available was low. However, when respondents were asked about their satisfaction with the adequacy of light in the rooms of their homes, about two-fifths (42%) said they were satisfied (Table 23). When asked, "Do you believe the light from this luminaire is sufficient for your tasks?" the respondents indicated only 24 of the 842 luminaires were inadequate. This suggests they were unaware of the deficiency of illumination for specific visual tasks, if indeed they are deficient.

Footcandles Available for Specific Visual Tasks

The lowest level of illumination recommended by the IES for any specific visual task is 30 footcandles. A comparison of the available footcandle readings with those recommended, showed that of the 789 readings taken, 641 (81%) were below 30 footcandles (Tables 20 and 21). The mode for the readings of all tasks performed was 10-14 footcandles of illumination from portable luminaires, and 5-9 footcandles of illumination from installed luminaires.

Social tasks.-Thirty footcandles are the minimum recommendation for social visual tasks. Of the 205 footcandle readings from portable luminaires, 163 (80%) provided 29 footcandles or less (Table 20). Most of these, 125 readings, were from 0 to 19 footcandles. Of the 96 readings from installed luminaires, 80 (83%) supplied 29 footcandles or less (Table 21). Sixty-eight (70%) of these readings were between 0 to 19 footcandles.

From all the luminaires, the task of **reading** was provided for better than any other tasks, and had the widest range, 0-9 to 70-79 footcandles. Hand sewing, handiwork, letter writing, hobbies, and playing the piano or organ had a few higher readings.

The recommendations are higher if the task involves discrimination of detail. The data depart strikingly from the recommendations. Recommendations for sewing are as high as 100 or 200 footcandles when for prolonged periods of time, or on dark fabric with low contrast thread. No reading was as high as recommended, and only three readings exceeded 50 footcandles (Tables 20 and 21). For reading advanced or sub-standard music scores, the recommendation is 70 footcandles. The highest reading in a household where the respondent read advanced music scores was 40-49 footcandles (Table 20).

Service tasks.-A minimum of 50 or 70 footcandles is the recommendation for all the service tasks, excluding cutting out fabric, some workshop tasks, and some machine sewing, where the minimum is 30 footcandles. The readings from both portable and installed luminaires were below this recommendation when used for service tasks. Only 5 luminaires

exceeded 50 footcandles. These were for work shop, food preparation and range activities. Most of the illumination for service tasks were from installed luminaires. Of the 347 readings from installed luminaires, 318 (92%) were 30 footcandles or less (Table 21). Most of these, 288 readings, were between 0-19 footcandles.

The service tasks with the greatest range of footcandles were range activities with 0-9 to 90-100 footcandles (Table 20), and machine sewing with 0-9 to 80-89 footcandles (Tables 20 and 21). Readings for record keeping with illumination from portable luminaires found a half giving 30 footcandles or over. The task having the lowest level of illumination was laundry.

Of the tasks requiring a minimum of 50 footcandles, only one footcandle reading for ironing and food preparation, two for workshop tasks and range activities and three for machine sewing were this high. For those tasks with a recommended minimum of 70 footcandles, sink activities and record keeping considered as studying, only one reading for record keeping provided 70-79 footcandles.

Personal tasks.-The minimum recommended footcandles for grooming and shaving was 50 footcandles. Of the 13 readings from portable luminaires, 11 were less than 50 footcandles (Table 20). Of the 97 readings from installed luminaires, 84 (87%) supplied 50 footcandles or less (Table 21).

TABLE 20.--Number of footcandle readings primarily from portable luminaires for specific visual tasks by rank order

Task	0-9	10-19	20-29	30-39	40-49	50-59	60 and over	Total
<u>Social tasks</u>								
Reading	33	34	22	12	4	2	2 ^a	109
Letter writing	2	8	3	3	1	1	-	18
Playing table games	5	3	5	1	-	-	-	14
Typing	4	-	-	-	-	-	-	4
Crossword puzzles	-	2	-	2	-	-	-	4
Hobbies	-	2	-	-	-	-	-	2
Handiwork	5	11	4	4	1	1	-	26
Hand sewing	4	6	4	4	1	1	1	21
Playing piano, organ	3	3	-	-	1	-	-	7
Total	56	69	38	26	8	5	3	205
<u>Service tasks</u>								
Cut out fabric	-	-	-	-	-	-	-	-
Workshop tasks	-	-	-	-	-	-	-	-
Machine sewing	-	2	3	2	1	1	2 ^b	11
Ironing	2	-	1	1	-	1	0	5
Laundry	-	-	-	-	-	-	-	-
Food preparation	-	-	-	-	-	-	-	-
Range activities	-	-	-	-	-	-	-	-
Food preservation	-	-	-	-	-	-	-	-
Sink activities	-	-	-	-	-	-	-	-
Record keeping	3	3	3	3	2	-	1 ^a	15
Total	5	5	7	6	3	2	3	31
<u>Personal tasks</u>								
Grooming	4	3	-	2	2	-	1	12
Shaving	-	-	-	-	-	-	1	1
Total	4	3	-	2	2	-	2	13

^a One reading 70-79.

^b One reading, 70-79, one reading 80-89.

TABLE 21.--Number of footcandle readings available primarily from installed luminaires for specific visual tasks by rank order

Task	0-9	10-19	20-29	30-39	40-49	50-59	60 and over	Total
<u>Social tasks</u>								
Reading	11	9	2	2	2	1	-	27
Letter writing	12	7	2	2	1	-	-	24
Playing table games	2	5	3	-	-	-	-	10
Typing	3	-	-	-	-	-	-	3
Crossword puzzles	-	-	-	-	-	-	-	-
Hobbies	-	6	1	-	1	1	-	9
Handiwork	4	-	1	2	1	-	-	8
Hand sewing	5	3	3	-	3	-	-	14
Playing piano, organ	1	-	-	-	-	-	-	1
Total	38	30	12	6	8	2	-	96
<u>Service tasks</u>								
Cut out fabric	2	2	1	1	1	-	-	7
Workshop tasks	1	3	2	1	1	1	1 ^a	10
Machine sewing	19	10	2	-	2	-	-	33
Ironing	32	16	2	2	-	-	-	52
Laundry	24	9	4	-	-	-	-	37
Food preparation	39	18	3	2	1	1	-	64
Range activity	25	12	6	4	1	-	2 ^b	50
Food preservation	9	8	2	-	2	-	-	21
Sink activities	27	19	6	1	3	-	-	56
Record keeping	10	3	2	-	2	-	-	17
Total	188	100	30	11	13	2	3	347
<u>Personal tasks</u>								
Grooming	18	10	9	10	6	5	1 ^c	59
Shaving	3	5	7	9	7	4	3 ^d	38
Total	21	15	16	19	13	9	4	97

a One reading 60-69.

b One reading 90-100.

c One reading 70-79.

d One reading 70-79, one reading 80-89.

Lumens Available by Rooms

The recommendations for the number of lumens per square foot by rooms are living and living-dining room and kitchen, 80 lumens; bedroom and laundry, 70 lumens; bathroom, 60 lumens; and dining room, 40 lumens. These recommendations consider the visual activities performed in the rooms. If rooms with the recommendation of 40 lumens were used for more critical visual tasks such as reading and record keeping, the recommendation of 80 lumens per square foot was used. Or, if rooms with the recommendation of 70 or 80 lumens were used primarily for less critical visual tasks, the recommendation of 40 lumens per square foot was used.

In this study the rooms requiring more light because of tasks performed in them had, on the average, more lumens per square foot but still were deficient (Table 22). For instance, in the living and living-dining rooms needing 80 lumens, the average lumens per square foot were 32, or about two-fifths of the recommendation. In those rooms needing 40 lumens per square foot, the average was 29, or about three-fourths of the recommendation. In the living and living-dining rooms, the lumens ranged from 6-10 to 66-70 and the mode was 26-30 lumens per square foot.

Dining rooms that needed a recommended 80 lumens per square foot, averaged 26 lumens, or not quite one-third of the recommendation. Those needing 40 lumens averaged 22, or about one-half the recommended lumens per square foot. The range of lumens in the dining rooms was from 6-10 to 65 to 75 lumens per square foot, and the mode was 21-25 and 26-30 lumens.

TABLE 22.--Number of lumens provided per square foot by lumens recommended^a per square foot in rooms

Lumens	Lumens recommended												
	L,L-D		DR		Den	F,F-D	K,K-D	Ut and other		BR	Bath		
	80	40	80	40	80	80	80	80	70	80	70	40	60
0-5	-	-	-	-	-	-	-	-	-	-	-	2	1
6-10	2	-	-	2	-	-	7	-	2	-	6	8	4
11-15	3	-	3	2	-	-	2	-	3	1	6	16	-
16-20	4	2	3	1	-	-	9	2	3	2	6	10	6
21-25	6	-	3	1	1	-	8	2	-	3	7	8	2
26-30	11	-	4	-	-	1	5	-	-	1	8	2	11
31-35	6	1	-	1	-	-	8	-	-	-	1	1	3
36-40	4	<u>-</u>	2	<u>-</u>	-	-	4	-	-	-	1	<u>3</u>	3
41-45	3	<u>-</u>	-	<u>-</u>	-	-	4	-	-	1	1	-	4
46-50	4	1	-	-	-	-	2	-	-	1	-	1	2
51-55	2	-	-	-	1	1	1	-	-	-	-	-	5
56-60	1	-	-	1	-	-	-	-	-	1	-	-	<u>2</u>
61-65	-	-	-	-	-	-	-	-	-	-	-	-	<u>2</u>
66-70	2	-	-	-	-	-	-	-	-	-	-	-	4
71-75	-	-	-	-	-	-	-	-	<u>-</u>	-	<u>-</u>	-	-
76-80	<u>-</u>	-	<u>1</u>	-	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	1	<u>-</u>	-	-	1
81-85	-	-	-	-	-	-	-	-	1	-	-	-	2
86-90	-	-	-	-	1	-	-	-	-	1	-	-	-
91-95	-	-	-	-	-	-	-	-	-	-	-	-	1
96-100	-	-	-	-	1	-	-	-	-	-	-	-	-
Totals	48	4	16	8	4	2	50	4	11	11	36	51	53
Avg.	32	29	26	22	65	40	27	19	20	35	20	18	40

^a Recommendations are at two levels in most rooms and are related to the requirements of the activities performed there.

The kitchen and kitchen-dining rooms averaged 27 lumens per square foot or about one-third of the recommended 80 lumens. The range was from 6-10 to 51-55 lumens per square foot, and the mode was 16-20.

Because of the tasks performed in the dens, they were considered to need 80 lumens per square foot. Of the four dens, two with 86-90 lumens exceeded the recommendations. One approached the recommendation having between 51-55 lumens, and the other had only between 21-25 lumens per square foot.

Utility and other rooms requiring 70 to 80 lumens averaged 20 lumens per square foot and ranged from 0-5 to 80-85 lumens per square foot. Two of these neared or exceeded the recommendations, but all the rest had only 30 or less lumens per square foot. Most of the activities performed in these rooms were done during the day. Many of the rooms had a large expanse of windows and required little artificial lighting.

The bathrooms requiring 60 lumens per square foot were the most adequately lighted room, average 40 lumens per square foot. The range was extremely wide, from 0-5 to 90-95 lumens per square foot. The mode was 26-30 lumens per square foot. One of the bathrooms was lighted only with a $7\frac{1}{2}$ watt night light and had 0-5 lumens.

The bedrooms were divided into three groups, those needing 40, 70 or 80 lumens per square foot. One bedroom exceeded the recommendations. All the others were low, but those needing more light averaged slightly higher. The average was 18 lumens per square foot in the rooms needing 40 lumens, 20 in the rooms needing 70, and 35 in the rooms needing 80. The range for all bedrooms was from 0-5 to 86-90 lumens per square foot.

Rooms Believed Most or Least Adequately Lighted

Respondents were asked which rooms of their homes they believed were most or least adequately lighted. Twenty-one households said all rooms were adequately lighted (Table 23).

The living and living-dining rooms were believed to be most adequately lighted by 28 households. Twenty named the kitchen and kitchen-dining rooms, and 10 named the dining rooms. Fewer mentioned the bedrooms and one named the den.

Of the rooms believed least adequately lighted, the bedrooms were named by 10 households, the living and living-dining rooms by seven, and the kitchen and kitchen-dining rooms by six. The dining rooms and bathrooms were mentioned by four and three households, respectively.

The living and living-dining rooms were the most adequately lighted rooms, except for the bathrooms. There were more footcandle readings above 30 footcandles for social tasks, most of which were performed in the living and living-dining rooms. More luminaires and the larger size of three-way bulbs were located there. However, those rooms still needed more illumination.

The kitchen and kitchen-dining rooms were not adequately lighted when comparing recommended footcandles to the available footcandles. There were only 10 footcandle readings above the recommended 50 footcandles for service tasks that were predominantly performed there.

TABLE. 23.--Number of rooms believed most or least adequately lighted
by 50 households

Room	Most adequate	Least adequate
L,L-D	28	7
DR	10	4
Den	1	-
F,F-D	-	-
K,K-D	20	6
Ut and other	-	-
Base and gar	-	-
BR	4	10
Bath	4	3
All rooms	21	-

Factors Affecting Quantity and Quality of Illumination

Negative Characteristics of Luminaires

The extent to which the illuminating sources, diffusion devices, lampshades, and location of luminaires affected the quantity and quality of illumination was determined for each of the luminaires. A scoring device (Appendix G) was developed and the characteristics in which the luminaires were lacking were noted.

There were few negative characteristics noted in the selection of type of luminaires, type of bulb, bulb number, outside color of lampshade, bulb position in the lampshade, and no bulb spot visible.

Portable luminaires.-Of the 300 portable luminaires, 127 (42%) lacked diffusion devices other than the lampshades (Table 24). About two-fifths (38%) were incorrectly positioned horizontally, and 29 percent were incorrectly positioned vertically. One-third (34%) lacked adequate bulb wattage. Over one-fourth (29%) did not have a white or light lining in the lampshades, and another one-fourth (26%) were of a shape to prevent good distribution of light. One-sixth (16%) of the luminaires were considered as not being the best choice for the tasks. Other negative characteristics were incorrect outside lampshade color, 11 percent; bulb spot visible through the lampshade, 9 percent; bulb position and type of bulb, 6 percent each; and lacking the correct number of bulbs, 4 percent.

Installed luminaires.-Of the 542 installed luminaires, 213 (39%) lacked adequate or did not have any diffusion devices (Table 25). Slightly over one-third (36%) had inadequate bulb wattage. One-fourth (24%) were in an incorrect position horizontally, but only 11 percent were in an incorrect position vertically. Other negative characteristics found to a lesser extent were incorrect bulb type, 11 percent; inadequate number of bulbs, 8 percent; and incorrect type of luminaire, 4 percent.

Reflectance Values of Room Surfaces

The reflectance values found in the rooms were compared to the recommended values of 60 to 90 percent for ceilings, 35 to 60 percent for walls, and 15 to 35 percent for floors. The trend in decorating for the past several years has been toward light colors, and most of the homes reflected this trend.

TABLE 24.--Number of negative characteristics of portable luminaires affecting quality and quantity of illumination by rooms

Room	Total luminaires	Illuminating source				Diffusion	Lamp shade					Position	
		Type of luminaire	Number of bulbs	Bulb type	Bulb wattage		Color inside	Color outside	Shape	Bulb spot visible	Bulb position	Horizontal	Vertical
L,L-D	140	15	3	3	38	62	35	12	38	9	10	64	36
DR	14	2	2	-	9	10	7	4	5	3	1	4	11
Den	8	3	-	-	1	3	2	2	3	1	-	5	2
F,F-D	2	-	-	-	1	1	1	-	-	-	-	1	1
K,K-D	2	-	-	-	1	1	-	-	-	-	-	1	1
Ut and other	1	1	-	-	-	1	-	-	-	-	1	1	1
Base and gar	15	3	-	-	5	3	3	1	1	1	-	5	3
BR	118	24	8	3	46	46	40	13	30	12	7	34	32
Bath	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	300	48	13	6	101	127	88	32	77	26	19	115	87
Percent		16	4	6	34	42	29	11	26	9	6	38	29

TABLE 25.--Number of negative characteristics of installed luminaires affecting quality and quantity of illumination by rooms

Room	Total luminaires	Illuminating source				Diffusion	Position	
		Type of luminaire	Number of bulbs	Bulb type	Bulb wattage		Hori-zontal	Ver-tical
L,L-D	41	1	-	1	7	4	5	4
DR	30	-	-	4	7	8	7	8
Den	2	1	-	1	1	-	2	1
F,F-D	5	-	-	-	-	-	-	-
K,K-D	141	6	21	13	77	33	44	18
Ut and other	17	1	-	3	4	5	11	2
Base and gar	126	4	9	14	38	125	24	5
BR	98	4	6	14	19	13	18	15
Bath	82	3	6	9	44	25	19	5
Total	542	20	42	59	197	213	130	58
Percent		4	8	11	36	39	24	11

Most of the ceilings, except in the basements, were of 60 percent or higher reflectance values (Table 26). The color used most often was white or off white. The basement ceilings were usually the color of the rough flooring and beams.

For walls, about half of the family and family-dining rooms, bedrooms, and basements were between 35 to 60 percent reflectance values (Table 27). About 40 percent of living and living-dining rooms and utility and other rooms were in this category, as were about a third of the dining rooms and kitchen and kitchen-dining rooms. One den had walls in this value group. Most of the remaining walls were of 61 percent or higher reflectance values. Only one den, utility and other room, and bedroom had reflectance values between 0 to 34 percent.

For floors, about two-thirds (62%) of the bedrooms and half of the family and family-dining rooms and basements had reflectance values of 15 to 35 percent (Table 28). About 40 percent of the living and living-dining rooms and dining rooms were in this group. Nearly a fifth to a fourth of the floors in dens, kitchen and kitchen-dining rooms, bathrooms, and utility and other rooms were within the 15 to 35 percent reflectance value. In nearly all the remaining rooms the floors had reflectance values of 36 percent or higher. The floors in one den, dining room, kitchen and kitchen-dining room, bedroom, bathroom, and two basements were between 0 to 14 percent reflectance values.

Since most reflectance values of room surfaces were of the desired percentage or higher, there was less loss of illumination due to absorption of light. Very few glossy finishes were observed, so the higher values did not appear glaring because of reflection of light.

TABLE 26.--Reflectance values of ceiling surfaces in rooms by rank order

Room	Total number of rooms	59 Percent and below		60-70 Percent		71 Percent and higher	
		Number	Percent	Number	Percent	Number	Percent
L,L-D	52	-	-	10	19	42	81
DR	24	-	-	5	21	19	69
Den	4	-	-	-	-	4	100
F,F-D	2	-	-	-	-	2	100
K,K-D	50	1	2	8	16	41	82
Ut and other	15	1	7	3	21	11	73
Base and gar	28	22	79	-	-	6	21
BR	98	1	1	13	13	84	86
Bath	53	3	6	20	38	30	56

TABLE 27.--Reflectance values of wall surfaces in rooms by rank order

Room	Total number of rooms	0-34 Percent		35-60 Percent		61 Percent and higher	
		Number	Percent	Number	Percent	Number	Percent
L,L-D	52	-	-	20	38	32	62
DR	24	-	-	7	29	17	71
Den	4	1	25	1	25	2	50
F,F-D	2	-	-	1	50	1	50
K,K-D	50	-	-	17	34	33	66
Ut and other	15	1	7	6	40	8	53
Base and gar	28	-	-	14	50	14	50
BR	98	1	1	48	48	50	51
Bath	53	-	-	28	53	25	47

TABLE 28.--Reflectance values of floor surfaces in rooms by rank order

Room	Total number of rooms	0-14 Percent		15-35 Percent		36 Percent and higher	
		Number	Percent	Number	Percent	Number	Percent
L,L-D	52	-	-	19	37	33	63
DR	24	1	-	10	42	14	58
Den	4	1	25	1	25	2	50
F,F-D	2	-	-	1	50	1	50
K,K-D	50	1	2	11	22	38	76
Ut and other	15	-	-	3	21	11	69
Base and gar	28	2	10	13	45	13	45
BR	98	1	2	61	62	36	34
Bath	53	1	3	9	17	42	80

Cleaning of Luminaires

Luminaires that are soiled cut down on the quantity of illumination. In reply to the question about how often luminaires were cleaned, most respondents asked if a truthful answer was wanted.

Sixteen households said ceiling luminaires were cleaned twice a year, six said three times a year, and seven said four times a year. Six households replied ceiling luminaires were cleaned once a year or less often. Of the remaining households most were cleaned once or twice a month.

For portable luminaires 25 households cleaned the fixtures either weekly or twice a month, and 12 cleaned them once a month. The rest indicated that cleaning was done once a year or less often.

Electrical Outlets

As noted, the quantity of illumination was low in the households. The addition of luminaires to provide more light is possible, only, if sufficient convenience electrical outlets and wiring are present in the rooms.

Outlets located in the wall, ranges in kitchen and kitchen-dining rooms, and in wall luminaires in the bathrooms were considered convenience outlets. The average for all rooms was three outlets, and the range was from one in 54 rooms to 15 outlets in one kitchen (Table 29). The average number of outlets per room was: living and living-dining, 4; dining, 2.5; den, 3.5; family and family-dining, 5.5; kitchen and kitchen-dining, 4.5; utility and other, 1.9; basements and garage, 2.6; bedrooms, 2.6; and bath, 1.7. There were 11 bathrooms, six bedrooms, five dining rooms, and three utility and other rooms that had no convenience outlet.

Safety and Convenience Features

The aged need to be aware of ways to prevent falls that are a common occurrence as they grow older. Two questions, one concerning the use of night lights and another on how light bulbs were changed in ceiling luminaires were asked. There was some indication that these aged people were concerned about safety. About half said they used night lights and two mentioned using a flashlight. The night lights usually were located in the bedrooms or bathrooms, but a few were found in the kitchen, kitchen-dining rooms, the living, living-dining rooms, and a hallway.

Thirty-eight of the households said they changed the light bulbs themselves, and 12 (usually women living alone) had some younger relative or cleaning lady change the bulbs for them. Regardless of who changed the bulb, 28 used a step ladder, 16 used a step stool, and six stood on chairs. One lady said she placed a chair on the table to stand on, since the ceiling was so high.

Some questions about features that might add to convenience in the homes were asked. All but one respondent said they kept extra bulbs on hand. Thirty-nine had lights controlled by switches, two by pull-chains, and nine had both switches and pull-chains. Most of these pull-chains were located in the basements.

All the light switches were within easy reach, at least 36 inches above the floor. Fifteen households had some electrical outlets other than in the kitchen and kitchen-dining rooms that were 18 inches above the floor level. Higher outlets help prevent unnecessary stooping and bending for the aged.

TABLE 29.--Number of convenience electrical outlets in rooms by rank order

Rooms	1	2	3	4	5	6	7	8	9 and above	Total number of rooms	Total number of outlets	Average
L,L-D	1	9	13	11	8	6	3	1	-	52	207	4.0
DR	3	8	7	-	-	-	1	-	-	19	47	2.5
Den	-	-	2	2	-	-	-	-	-	4	14	3.5
F,F-D	-	-	-	-	1	1	-	-	-	2	11	5.5
K,K-D	1	4	11	7	17	7	1	-	2	50	228	4.6
Ut and other	5	4	2	1	-	-	-	-	-	12	23	1.9
Base and gar	8	6	5	5	1	2	-	1	-	28	80	2.6
BR	18	25	32	14	3	-	-	-	-	92	235	2.6
Bath	18	18	6	-	-	-	-	-	-	42	72	1.7
Totals	54	74	78	40	30	16	5	2	2	301	917	3.0

SUMMARY AND CONCLUSIONS

Summary

One-fifth of the independent households having one person between the ages of 65 and 74 years were randomly selected in Clay Center, Kansas for interview. The objective was to determine the adequacy of the home lighting and whether or not an educational program was needed by the aged to improve lighting in their homes.

In the 50 households were 82 respondents of whom two-thirds were couples, and one-fifth were women living alone. Seventy-four of the respondents were retired from their former occupation, but 18 worked part time. Incomes ranged from under \$3,000 to over \$7,000, and two-fifths had incomes of \$3,000 or less. All owned their homes. The median educational level attained was the eighth grade or less. Women averaged more years of education than men. All wore glasses when performing visual tasks.

Visual tasks were categorized as: social, service, and personal. Social tasks were predominantly performed in the living and living-dining and kitchen and kitchen-dining rooms. All households read and 94 percent watched TV. Nearly two-thirds did some hand sewing and letter writing, a half did handiwork, and a third played table games. Other social tasks performed were playing the piano or organ, working crossword puzzles, hobbies, and typing. Service tasks were predominantly performed in the kitchen and kitchen-dining rooms, bedrooms and basements. All prepared food, three-fourths ironed, and about two-thirds did laundry and machine sewing. Two-fifths kept records and preserved food. Fewer performed

workshop tasks and cut out fabric. The personal tasks were performed predominantly in the bathrooms.

Illumination was provided by 842 luminaires, 300 portable and 542 installed luminaires in the 326 rooms used for specific visual tasks, averaging 2.5 luminaires per room. Types of portable luminaires were table, floor, dresser, pole and other, wall pin-up and bed. About one-half were in the living and living-dining rooms and two-fifths were in bedrooms. Installed luminaires were ceiling, ceiling drop cord, wall, recessed ceiling, range or hood, and pull-down wall or ceiling. About a fourth were in the kitchen and kitchen-dining rooms and another fourth in the basements and garage, one-third in bedrooms and bathrooms.

Portable luminaires provided illumination primarily for social tasks and installed luminaires for service and personal tasks. Table and floor luminaires were used more for the social tasks than other types. Ceiling luminaires supplied illumination mainly for food preparation, sink activities, ironing, and machine sewing. Ceiling drop cords were used for laundry and workshop tasks. Providing illumination for grooming were primarily wall and ceiling luminaires.

Over half of the 1,006 one-way incandescent bulbs were 60 watts or less. Sixty-one three-way bulbs were used mainly in the living and living-dining rooms. Of the 64 fluorescent bulbs, about three-fifths were low wattage, used predominantly in the kitchen and kitchen-dining rooms.

Income was associated with the choice of bulb wattage. Sixty-four percent of incandescent bulbs used by the low income group were 60 watts or less as compared to 42 percent for the high income group. The most

common size bulb used by the high income group was 100 watts. Of the fluorescent bulbs, 90 percent of those used by the low income group were 20 watts or less as compared to 63 percent by the high income group.

Quantity of illumination as determined by footcandle readings was low, compared to the recommendations. Four-fifths of the footcandle readings provided 30 footcandles or less. The mode was 10-14 footcandles for portable luminaires and 5-9 footcandles for installed luminaires. The aged people in this study were not aware of this deficiency. Two-fifths of the households believed their homes were adequately lighted. The rooms believed to be most adequately lighted were the living and living-dining rooms, and least adequately lighted were the bedrooms.

The number of lumens per square foot was low compared to the recommendations. The mode for all rooms was 16-20 lumens per square foot as compared to a recommended 40, 60, 70, or 80 lumens per square foot.

Consideration was given to the characteristics affecting quantity and quality of illumination. Portable luminaires lacked diffusion devices, had insufficient bulb wattage, were horizontally and vertically in an incorrect position, and the inside of many lampshades was not the desired white or light color. Installed luminaires lacked adequate diffusion devices, had insufficient bulb wattage, and were in a position that was horizontally incorrect. Ceiling luminaires generally were cleaned two or three times a year and portable luminaires weekly or bimonthly.

Room surfaces were usually light in hue. Most of the reflectance values for ceilings, walls, and floors were as high or higher than the minimum recommendation, except for the bedrooms and basements.

There was some awareness of lighting safety features in the homes as about a half used night lights, located primarily in bathrooms and bedrooms. Three-fourths of the households changed the light bulbs themselves using step ladders and step stools. However, six stood on chairs.

Lights were controlled mainly by switches and not pull-chains, and were located at least 36 inches above the floor. The average number of convenience outlets for all rooms was three. Only 15 households had electrical outlets conveniently located 18 inches or more above the floor in rooms other than the kitchen and kitchen-dining rooms.

Conclusions

Good lighting is required by those persons between the ages of 65-74 years in Clay Center, Kansas because many of the visual tasks they performed involved discrimination of details. These tasks included reading, machine and hand sewing, handiwork, record keeping and workshop tasks. Other tasks such as watching TV, as do all visual tasks, require light comfortable for vision.

Assistance is needed by this aged population to improve lighting in their homes. Two-fifths (40%) of those in the study expressed satisfaction with the adequacy of lighting in their homes. However, they apparently were unaware of deficiencies in both quantity and quality of light.

Quality and quantity of illumination needs to be improved. Consideration must be given to negative characteristics that affect these two factors of illumination.

The most obvious lack in quality of illumination was diffusion of light. Two-fifths (42%) of all luminaires lacked diffusion devices. Also, many of the subjects did not use general lighting with local light to create a good balance of illumination between the task and surroundings.

All rooms need a greater quantity of illumination. Low quantity of illumination was shown by the fact that four-fifths (81%) of the foot-candle readings were less than the minimum recommendation for any specific visual task.

Lumens per square foot were low compared to recommendations of 40, 70, 80 lumens per square foot. The mode was 16-20 lumens per square foot for all rooms in the households.

Methods of increasing quantity of illumination needed by these respondents were to increase the wattage of the bulbs used, to learn better positioning of the luminaires, and to increase the frequency of cleaning.

The rooms believed to be the most adequately lighted were the living and living-dining rooms. There were more footcandle readings above 30 footcandles for social tasks, most of which were performed in the living and living-dining rooms. In addition, more luminaires and the large size of three-way bulbs were located there. The average of 32 lumens per square foot was only two-fifths (40%) of the recommendation.

The kitchen and kitchen-dining rooms were frequently named as the most adequately lighted rooms. This was not true. There were only ten

footcandle readings above the recommended 50 footcandles for service tasks that were predominantly performed there. The lumens per square foot averaged only a third of the recommendation.

There are some aspects of illumination in which these aged persons apparently are well informed. The types of luminaires chosen were in the main satisfactory. Ceiling, wall, and floor surface reflectance values were as high or higher than recommendations. They were paying some attention to the provision of "nights lights", and were in general observing good practices for relamping.

Consumer information is needed to provide the best light they can afford. This is true because little money is available for expensive luminaires, as two-fifths (38%) had incomes of \$2,999 or less.

An educational program is needed by the aged to improve lighting in their homes. Focus should be on quantity, but always with the understanding that quality of light is as important. Plates I to VI (Appendix) have been developed as a first step toward an educational program.

SELECTED BIBLIOGRAPHY

- Agan, Tessie and Luchsinger, Elaine. The House, Principles/Resources/Dynamics. Philadelphia: J. B. Lippincott Co., 1965.
- Avery, Sylvester K. Household Physics. 3rd ed. revised. New York: Macmillan Co., 1955.
- Blackwell, R. H. "Development and Use of a Quantitative Method of Interior Illumination Levels on Basis of Performance Data," Illuminating Engineering, Vol. 54 (June, 1959), 318-353.
- Crouch, C. L. "Lighting Needs for Older Eyes," Journal of the American Geriatrics Society, Vol. 15 (July, 1967), 685-688.
- Ferree, C. B., and Rand, G. "The Effect of Intensity of Illumination on the Near Point of Vision and A Comparison of the Effect for Presbyopic and Non-Presbyopic Eyes," Transactions of Illuminating Engineering Society, Vol. 28 (1933), 590-611.
- Guth, Sylvester K., Eastman, A. A., and McNelis, J. F. "Lighting Requirements for Older Workers," Illuminating Engineering, Vol. LI, No. 10 (October, 1956), 656-660.
- "Home Lighting Bulb Guide," General Electric Large Lamp Department, Technical Publication TP-101, Nela Park, Cleveland.
- Illuminating Engineering Society. IES Handbook. 4th ed. Baltimore: Waverly Press, Inc., 1966.
- Illuminating Engineering Society. "Recommended Practice for Residence Lighting," Illuminating Engineering, Vol. 48 (August, 1953), 413-445.
- "Light and Interior Finishes," General Electric Large Lamp Department Technical Publication TP-129, Nela Park, Cleveland.
- McFarland, Ross A. "The Sensory and Perceptual Processes in Aging." Paper presented at the Conference on Theory and Methods of Research on Aging, West Virginia University, May, 1967.
- McFarland, R. A., and Fisher, M. B. "Alterations in Dark Adaptation as a Function of Age," Journal of Gerontology, Vol. 10 (1955), 424-428.
- McFarland, R. A., and Domey, R. G. "Experimental Studies of Night Vision as a Function of Age and Change of Illumination," Highway Research Board Bulletin, No. 191 (1958), 17-19.
- Miles, W. R. "Age and Human Ability," Psychological Review, XXXX (June, 1933), 113-114.

- President's Council on Aging. The Older American. 1963.
- Roberts, Jean. "Binocular Visual Acuity of Adults," U. S. Department of Health, Education, and Welfare, Series 11, No. 3 (June, 1964), 1-11.
- Rockwell Engineering Company. 2121 East 45th Street, Indianapolis, Ind. Letter, March 22, 1968.
- Seagers, Paul W. Light, Vision, and Learning. New York: Better Light Better Sight Bureau, 1963.
- "See Your Home in a New Light," Developed by General Electric Residential Engineers, Nela Park, Cleveland. 4th ed.
- State Interdepartmental Committee on Aging. The Older Kansan. State Office Building, Topeka, Kansas, 1963.
- "The Lumen Counter," General Electric Co., Nela Park, Cleveland, (January, 1967).
- Tinker, Miles A. "Illumination Standards for Effective and Easy Seeing," Psychological Bulletin, Vol. 44 (September, 1947), 435-448.
- U. S. Bureau of Census. Eighteenth Decennial Census of the United States: 1960. Population, Vol. 1, Part 18.
- U. S. Bureau of Census. Housing of Senior Citizens: 1960. Vol. VII.
- U. S. Department of Commerce, "The Extent of Poverty in the United States 1959 to 1966," Current Population Reports, Consumer Income, Series P-60, No. 54 (May, 1968).
- U. S. Department of Health, Education, and Welfare, Administration on Aging. Facts About the Older American. AOA Publication No. 410, (May, 1966).
- Weale, R. A. Behavior, Aging, and the Nervous System. A. T. Welford and J. E. Birren, (eds.) Springfield: Charles C. Thomas, 1965.
- Weiss, Alfred D. Handbook of Aging and the Individual, Psychological and Biological Aspects. J. E. Birren, (ed.), Chicago: University of Chicago Press, 1959.
- Wolf, E. "Glare and Age," Archives of Ophthalmology, LXIV, (October, 1967), 502-513.

APPENDICES

APPENDIX A

I.E.S. CURRENTLY RECOMMENDED LEVELS OF ILLUMINATION*

SPECIFIC VISUAL TASK	Minimum foot-candles
Kitchen activities	
sink	70
range and work surfaces	50
Laundry	
trays, ironing board, ironer	50
Reading and writing, including studying	
books, magazines, newspapers	30
handwriting, reproductions, poor copies	70
Study desks	70
Sewing	
dark fabrics (find detail, low contrast)	200
prolonged periods (light to medium fabrics)	100
occasional periods (light fabrics)	50
occasional periods (coarse thread, large stitches, high contrast thread to fabric)	30
Grooming	
shaving, make-up, grooming	50
Workshop	
rough sawing and bench-work	30
sizing, planing, rough sanding, gluing, veneering, medium quality benchwork	50
fine bench-work, fine sanding and finishing	100
Table games	30
Reading music scores	
beginner, or simple score	30
advanced score	70

* Illuminating Engineering Society. Lighting Handbook, 4th ed. (1966).

APPENDIX B

USE OF LIGHT IN CRITICAL VISUAL TASKS OF PERSONS
65 - 74 YEARS OF AGE IN CLAY CENTER, KANSAS

Schedule Number _____
Date _____

Department of Family Economics
Kansas State University

PERSONAL DATA

I would like some information about you that will be helpful in the study.

1. How long have you lived in Clay Center?

a) _____ Less than 2 years	d) _____ 10-19 years
b) _____ 2-5 years	e) _____ 20 years
c) _____ 6-9 years	f) _____ All my life
2. How long have you lived in this house? _____
3. Do you own or rent your house? _____ Own _____ Rent
4. Which of the following best describes the member or members living in the household?

a) _____ woman living alone
b) _____ man living alone
c) _____ couple
d) _____ man living with other adult. Who? _____
e) _____ woman living with other adult. Who? _____
5. Are you retired? _____ yes; _____ no*
6. (If retired) What was your previous occupation?*
7. (If not retired) Are you employed full time or part time? * _____ Full time _____ Part time
8. What is your present occupation? _____
9. Does your employment require close work and use of your eyes? *
_____ Yes; _____ No; _____ Partial.
10. How many years of formal education did you complete? *

a) _____ 8th grade or less	d) _____ some college
b) _____ some high school	e) _____ college graduate and beyond
c) _____ high school	f) _____ trade school
11. On this card is a breakdown of income brackets. Would you please check the bracket which most nearly describes your present income.

a) _____ Under \$1,000	e) _____ 3,000 - 3,999	i) _____ 7,000 - 9,999
b) _____ 1,000 - 1,499	f) _____ 4,000 - 4,999	j) _____ 10,000 and over
c) _____ 1,500 - 1,999	g) _____ 5,000 - 5,999	k) _____ Don't know
d) _____ 2,000 - 2,999	h) _____ 6,000 - 6,999	l) _____ Refused

*Code - R = Respondent; W = Wife; H = Husband; S = Sister; B = Brother;
A = Aunt; U = Uncle.

12. I have assumed you are between the ages of 65-74. Is this correct? ___
Your husband/wife is closest to which of these age brackets?*
- | | |
|--------------|-----------|
| ___ Under 65 | ___ 75-84 |
| ___ 65-74 | ___ 85-90 |
13. Do you wear glasses when doing any activities?*
- ___ Yes; ___ No; ___ Usually
14. When was the last time you had your eyes checked?*
- | | |
|-----------------------------|----------------------------|
| a) ___ Within last 6 months | d) ___ 2-3 years ago |
| b) ___ 6 months - 1 year | e) ___ 4 or more years ago |
| c) ___ 1 - 2 years ago | |

GENERAL

The next questions pertain to the lighting in your home.

15. In which room or rooms do you believe your lighting is best? _____
Which room or rooms is it least adequate? _____
16. Do you have the general lighting (ceiling lights) turned on with local lighting when doing any activity requiring close use of your eyes?
___ Yes ___ No ___ Usually
17. Do you watch television in a dark, lighted, or partially lighted room?
___ Dark ___ Lighted ___ Partially lighted
18. How do you think the light from four 25 watt bulbs compares to one 100 watt bulb? ___ More ___ Same ___ Less ___ Don't know

SAFETY, CONVENIENCE, AND CARE

19. Do you use any type of night light? ___ Yes ___ No
In what room or rooms? _____
20. How do you change the light bulb in your ceiling fixtures? _____
21. Do you keep extra bulbs on hand? ___ Yes ___ No ___ Usually
22. Are your lights controlled by switches or pull chains?
___ Switches ___ Pull-chain ___ Both
23. Are any light switches 36 inches above floor level?
___ Yes ___ No
24. Are any of the electrical outlets, other than in the kitchen, 18 inches above the floor level? ___ Yes ___ No
25. How often do you clean bulbs and light fixtures?
Ceiling _____ Portable _____

Schedule No. _____	Room _____ Size _____ No. of electrical outlets _____	Room _____ Size _____ No. of electrical outlets _____	Room _____ Size _____ No. of electrical outlets _____
<u>LUMINAIRE</u>			
Type			
Bulb: Number of watts, type			
Correctly located			
<u>Horizontally</u>			
<u>Vertically</u>			
<u>QUALITY OF LIGHT</u>			
Diffusion			
Shade			
<u>Color inside</u>			
<u>Color outside</u>			
<u>Shape</u>			
<u>Bulb spot visible</u>			
<u>Bulb position</u>			
Other diffusion devices			
Reflectance			
<u>Work plane</u>			
<u>Wall finish</u>			
<u>Ceiling finish</u>			
<u>Floor finish</u>			
Negative qualities			
<u>USE OF LUMINAIRE</u>			
Tasks			
Number of foot-candles provided			
For general or local lighting or both			
Do you believe this light is sufficient for activities you do here?			

APPENDIX C

Kansas State University

92

Manhattan, Kansas 66502

Department of Family Economics
Justin Hall

Dear

I am studying for a Master of Science Degree in the Department of Family Economics at Kansas State University. I have become interested in good lighting, especially for the age group of my parents. They have become aware of the need to prevent eyestrain.

I invite you to participate in my study, and I hope you will. I will need to visit twice in your home. The first visit will be during the daytime, and then I will need to return the same evening for a short time. What you tell me about your lighting will be used in fulfillment for the requirements for my degree, and all information will be kept strictly confidential.

I will be knocking on your door sometime in the next few weeks.

Sincerely,

Alice Frey

AF:mc

APPENDIX D

Schedule Number _____

11. ON THIS CARD IS A BREAKDOWN OF INCOME BRACKETS. WOULD YOU PLEASE CHECK THE BRACKET WHICH MOST NEARLY DESCRIBES YOUR PRESENT INCOME?

(a) _____ Under \$1,000
(b) _____ 1,000 - 1,499
(c) _____ 1,500 - 1,999
(d) _____ 2,000 - 2,999
(e) _____ 3,000 - 3,999
(f) _____ 4,000 - 4,999

(g) _____ 5,000 - 5,999
(h) _____ 6,000 - 6,999
(i) _____ 7,000 - 9,999
(j) _____ 10,000 and over
(k) _____ Don't know
(l) _____ Refused

APPENDIX E



March 22, 1968

Kansas State University
Manhattan,
Kansas 66502

Attention: Tessie Agan
Associate Professor

Gentlemen:

Re: Weston Light Meter Model 614
Serial Number 4570

We are providing the number of scale divisions error at each calibrating point on each of the three scales.

We have done this purposely since sometimes expressions of percentage are more difficult to interpret since they may relate to full scale reading or the actual reading point. In any event, with this table you can determine the foot candle reading of any point, say, for instance, the mid-point on the low range shows a 3.5 divisions error in the negative sense (minus 3.5 divisions error). To determine the correction therefore you reverse the sign and add. If the pointer were sitting on 30 divisions it would represent 3 divisions low so the true reading would be 33.5. The same principle applies to all of the balance of the readings.

Should you have additional questions, please let us know.

Sincerely,

H. P. Rockwell, Jr.

HPR:wd

Encl.



3/22/68

TEST REPORT

Weston Model 614, S/N 4570

as received

	RANGE	DIVISIONS ERROR
Low	0	0
	10	+ 1
	20	- 1
	30	- 3.5
	40	- 6.5
	50	- 9.5
	60	-14
Intermediate	20	- 1
	40	- 3
	60	- 5.5
	80	- 8.5
	100	-11.5
	120	-16
High	100	- 1.5
	200	- 3.5
	300	- 6
	400	- 9
	500	-12
	600	-16.5

APPENDIX F

Bulb Usage by Two Income Levels

Analyses by the t-test

Incandescent Bulbs

Income under \$2,999 N = 16			Incomes over \$7,000 N = 8		
Number of bulbs	Total wattage	Average wattage used per household	Number of bulbs	Total wattage	Average wattage used per household
18	1065	59.1	30	2165	72.2
8	635	79.4	25	1530	61.2
11	740	67.3	33	1635	49.5
16	850	53.1	27	2180	80.7
23	1620	70.4	20	1570	79.0
26	1825	70.1	32	3140	98.0
10	615	61.5	45	3420	76.0
26	1065	41.0	24	1970	82.1
16	850	53.1			
11	790	71.8			
16	795	49.7			
9	535	59.4			
14	880	62.9			
15	970	64.7			
11	625	56.8			
15	1110	74.0			

$$\bar{x}_1 = 62.1 \quad \bar{x}_2 = 74.8 \quad \bar{d} = 12.7 \quad S_{\bar{d}} = 5.04$$

$$H_0(u_1 = u_2 | \sigma_1^2 = \sigma_2^2) \text{ vs } H_a(u_1 < u_2)$$

$$t = \frac{12.7}{5.04} = 2.51, ** \quad P = 0.01$$

Conclusion: The $H_0(u_1 = u_2)$ is rejected in favor of the alternative,

$H_a(u_1 < u_2)$.

Fluorescent Bulbs

Incomes under \$2,999 N = 10 ^a			Incomes over \$7,000 N = 6 ^a		
Number of bulbs	Total wattage	Average wattage used per household	Number of bulbs	Total wattage	Average wattage used per household
2	50	25.0	5	95	19.0
1	20	20.0	4	56	14.0
4	70	17.5	3	50	17.0
1	15	15.0	2	60	30.0
1	14	14.0	3	85	28.3
3	29	9.7	7	141	20.1
1	20	20.0			
1	20	20.0			
2	40	20.0			
3	35	11.7			

$$\bar{x}_3 = 17.29 \quad \bar{x}_4 = 12.84 \quad \bar{d} = 4.45 \quad s_d^2 = 2.75$$

$$H_0(u_3 = u_4 \mid \sigma_3^2 = \sigma_4^2) \text{ vs } H_a(u_3 \neq u_4)$$

$$t_{14} = \frac{4.45}{2.75} = 1.62 \quad P = 0.10$$

Conclusion: The $H_0(u_3 = u_4)$ is accepted.

^a Households not having fluorescent bulbs were not included in N.

APPENDIX G

Scoring for Characteristics of Luminaires

A scoring device was established for determining the acceptability of the characteristics of luminaires. The IES Lighting Handbook (1966), Section 15, and General Electric's "See Your Home in a New Light," were used to determine acceptability of the characteristics. These references listed suitable lighting installation, bulb size and type, diffusion devices, lampshades, and positioning of luminaires for specific visual tasks. Acceptable characteristics were rated 2, and if unacceptable the characteristic was rated 0.

Scoring of Characteristics

Illuminating Source	8
1. Type of luminaire suitable for tasks	2
2. Number of bulbs adequate	2
3. Bulb type satisfactory	2
4. Bulb wattage adequate for task	2
Diffusion device other than lampshade	2
Lampshade	10
1. Color inside, white or off white	2
2. Color outside, light	2
3. Shape, wide bottom, not extremely tall	2
4. Bulb spot not visible	2
5. Bulb located in center or low in shade (for tall shade, bulb low in shade)	2

Position of Luminaires	4
------------------------------	---

Portable

Table

Horizontally - 20 inches left or right
and 16 inches back of task center 2

Vertically - Bottom of shade eye level 2

Floor

Horizontally - 15 inches left or right
and 26 inches back of task center 2

Vertically 2

Desk

Horizontally - 15 inches to left (or
right if left handed) and 12 inches
back from task center 2

Vertically - Bottom of shade 12 inches
above desk top 2

Installed

Horizontally - located above task area 2

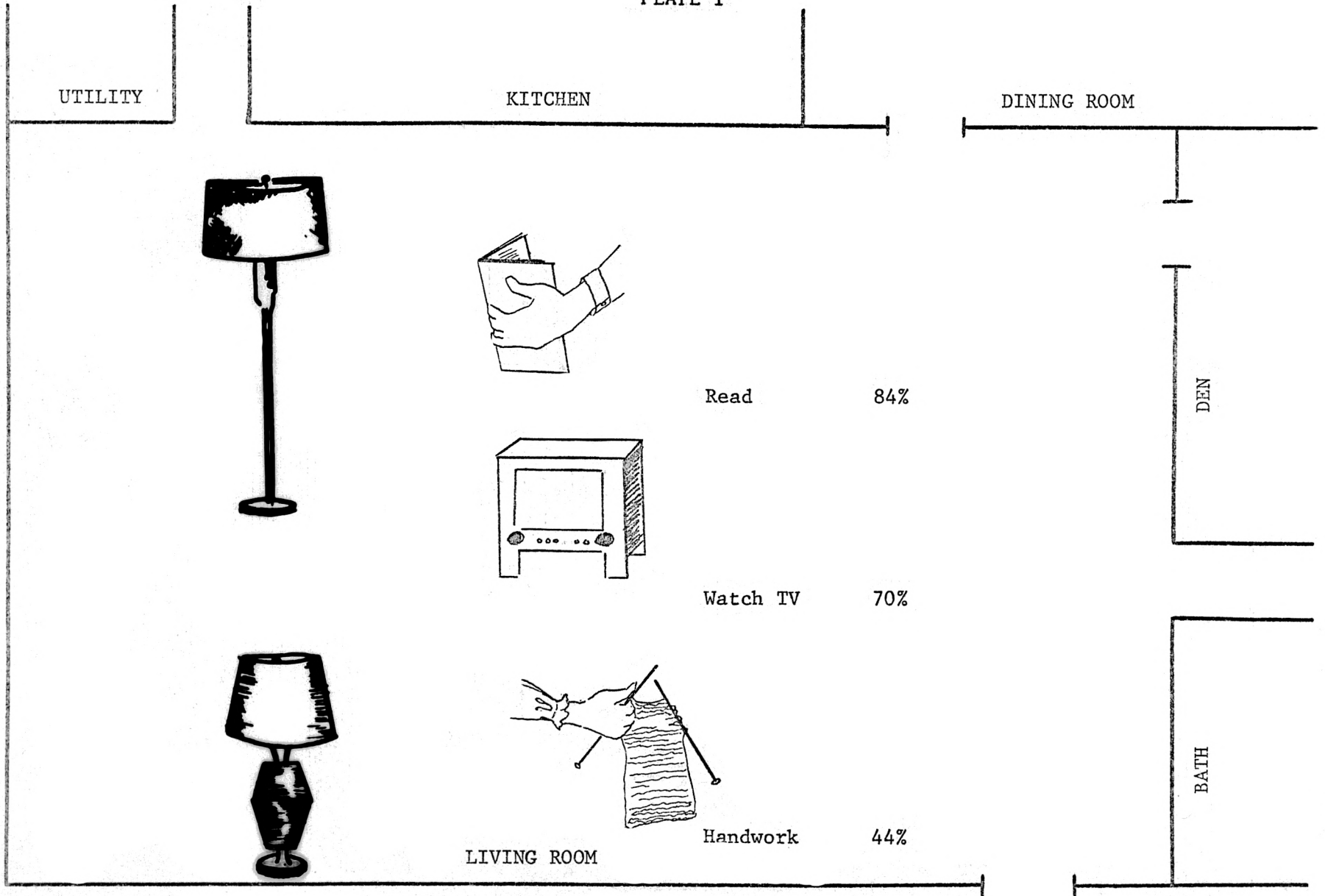
Vertically - Close to task area 2

PLATES

EXPLANATION OF PLATE I

Visual tasks performed predominantly in the living and living-dining rooms. The transparency shows recommended luminaires for these tasks.

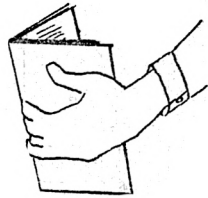
PLATE I



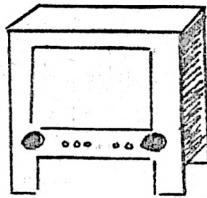
UTILITY

KITCHEN

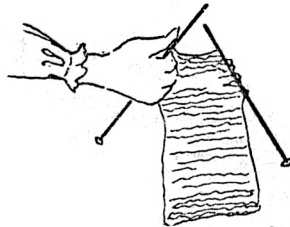
DINING ROOM



Read 84%



Watch TV 70%



Handwork 44%

LIVING ROOM

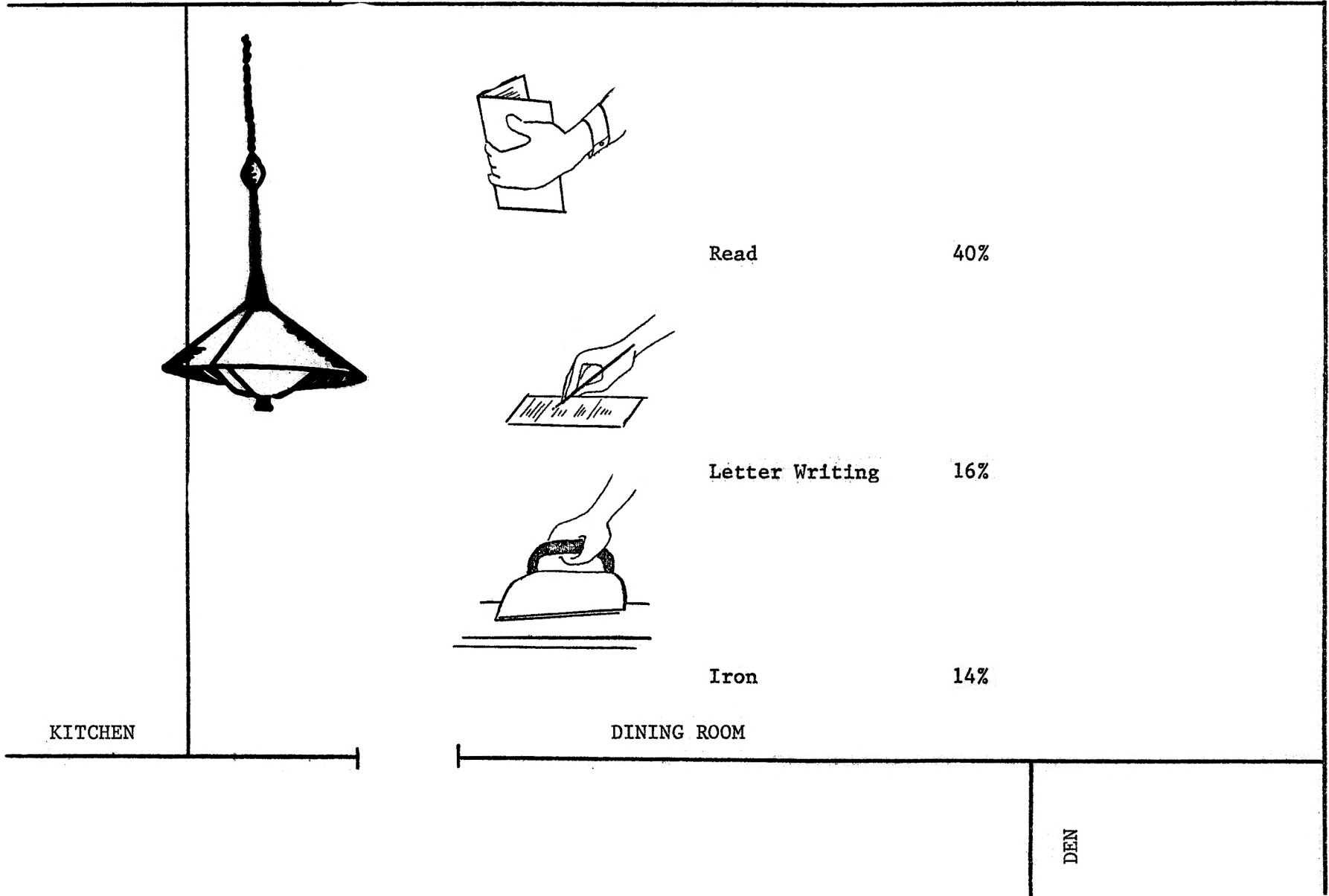
DEN

BATH

EXPLANATION OF PLATE II

Visual tasks performed predominantly in the dining rooms. The transparency overlay shows a recommended luminaire for the tasks.

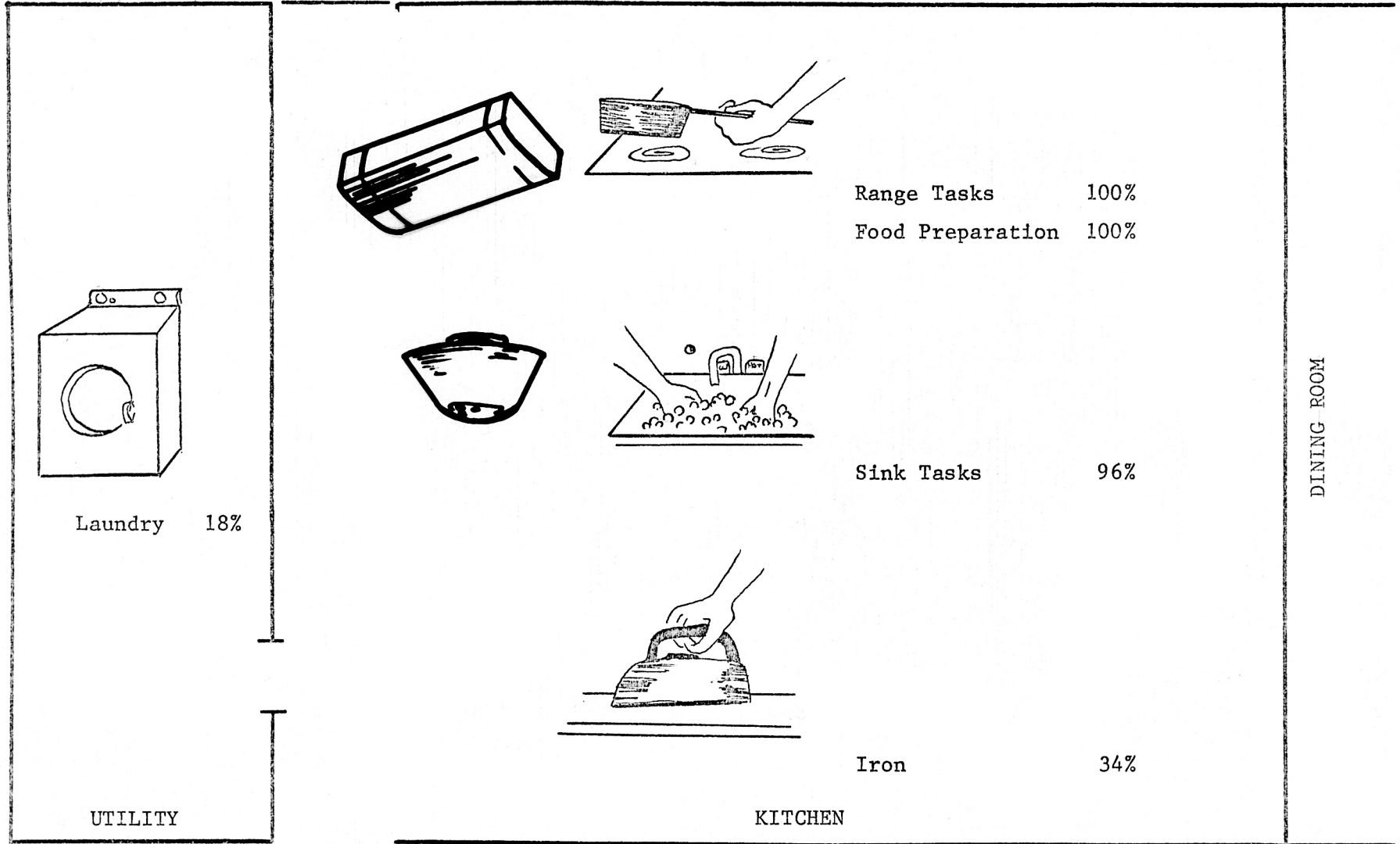
PLATE II



EXPLANATION OF PLATE III

Visual tasks performed predominantly in the kitchen, kitchen-dining rooms. The transparency overlay shows recommended luminaires for the tasks.

PLATE III

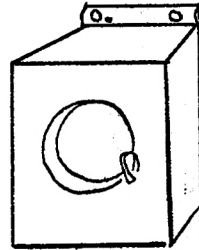


LIVING ROOM

EXPLANATION OF PLATE IV

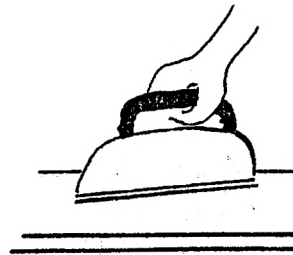
Visual tasks predominantly performed in the basements. The transparency overlay shows a recommended luminaire for the tasks.

PLATE IV



Laundry

40%



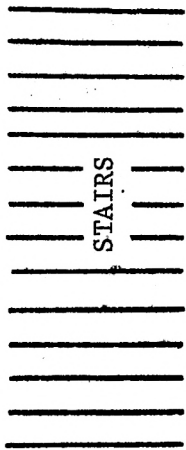
Iron

20%



Workshop Tasks

18%

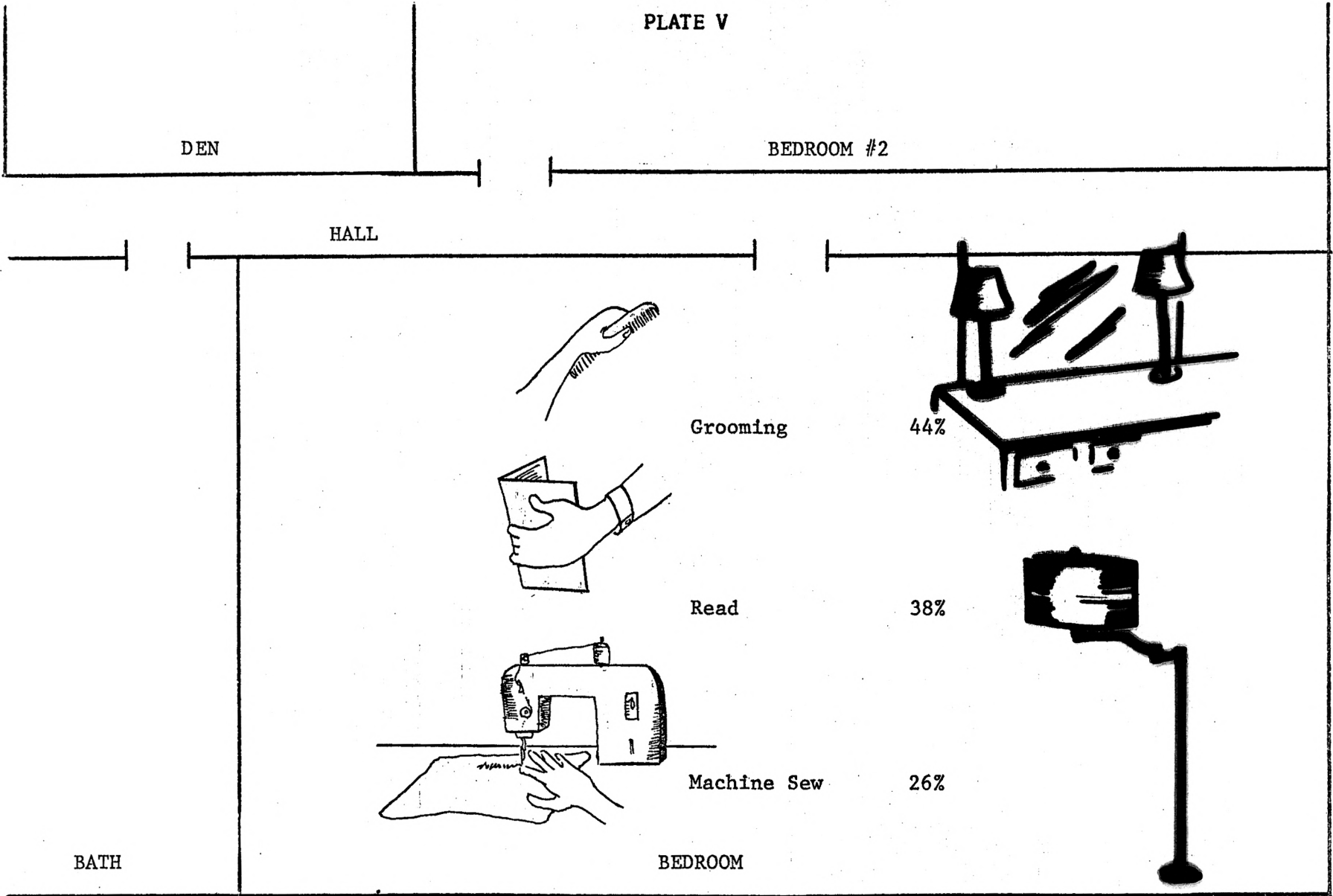


BASEMENT

EXPLANATION OF PLATE V

Visual tasks performed predominantly in the bedrooms. The transparency shows recommended luminaires for the tasks.

PLATE V



EXPLANATION OF PLATE VI

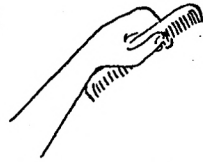
Visual tasks performed predominantly in the bathrooms. The transparency shows a recommended luminaire for the tasks.

PLATE VI

DEN

HALL

LIVING ROOM

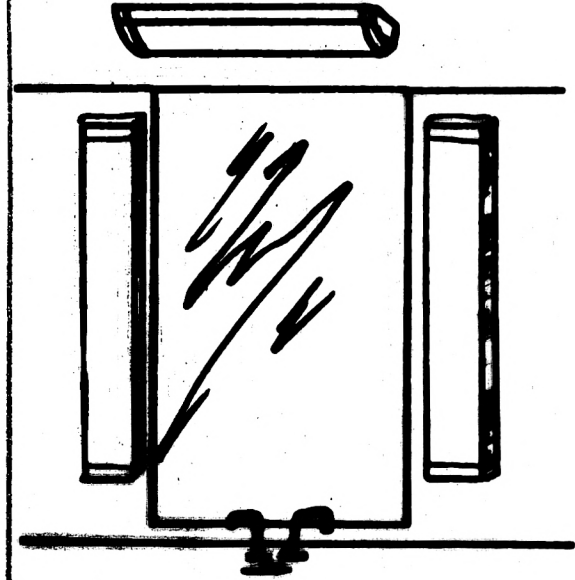


Grooming 92%



Shaving 62%

BATH



BEDROOM

USE OF LIGHT IN SPECIFIC VISUAL TASKS OF
PERSONS 65 TO 74 YEARS OF AGE IN CLAY CENTER, KANSAS

by

ALICE LETTIE FREY

B. S., Kansas State University, 1955

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Family Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1969

The purpose of this research was to determine if an educational program was needed by the aged population of Clay Center, Kansas to improve lighting in their homes. The objectives were to investigate (1) the visual tasks performed, (2) facilities for lighting, and (3) quantity of illumination available in homes of persons 65 to 74 years of age.

Fifty independent households of the chosen age range were randomly selected in Clay Center, Kansas for personal interview. In the sample were 82 persons, mostly couples. Seventy-four were retired, others worked part time to supplement their incomes. Incomes ranged from less than \$3,000 to over \$10,000, with about two-fifths having less than \$3,000.

Good lighting is required by those persons between the ages of 65-74 years in Clay Center, Kansas because many of the visual tasks they performed involved discrimination of details. Those tasks included reading, machine and hand sewing, handiwork, record keeping, and workshop tasks. Other tasks such as watching TV, as do all visual tasks, require light comfortable for vision.

Assistance is needed by this aged population to improve lighting in their homes. Two-fifths (40%) of those in the study expressed satisfaction with the adequacy of lighting in their homes. However, they apparently were unaware of deficiencies in both quantity and quality of light.

The most obvious lack of quality of illumination was diffusion of light. Two-fifths (42%) of all luminaires lacked diffusion devices.

Also, many of the subjects did not use general lighting with local light to create a good balance of illumination between the task and surroundings.

All rooms need a greater quantity of illumination. Low quantity of illumination was shown by the fact that four-fifths (81%) of the footcandle readings were less than the minimum recommendation for any specific visual task.

Lumens per square foot were low compared to recommendations of 40, 70 and 80 lumens per square foot. The mode was 16-20 lumens per square foot for all rooms in the households.

Methods of increasing quantity of illumination needed by these respondents were to increase the wattage of the bulbs used, to learn better positioning of the luminaires, and to increase the frequency of cleaning.

The rooms believed by respondents to be the most adequately lighted were the living and living-dining rooms. There were more footcandle readings above 30 footcandles for social tasks, most of which were performed in the living and living-dining rooms. In addition, more luminaires and the large size of three-way bulbs were located there. The average of 32 lumens per square foot was only two-fifths (40%) of the recommendation.

The kitchen and kitchen-dining rooms were named frequently as the most adequately lighted room by the respondents. This was not true. There were only 10 footcandle readings above the recommended 50 footcandles for service tasks that were performed predominantly in the

kitchen and kitchen-dining rooms. The lumens per square foot averaged only a third of the recommendation.

The aged persons serving as subjects for this study apparently are well informed concerning some aspects of illumination. The types of luminaires chosen were, in the main, satisfactory. Ceiling, wall, and floor surface reflectance values were as high or higher than recommendations. The interviewers were paying some attention to the provision of "night lights", and were in general observing good practices for relamping.

The aged population sampled for this study need consumer information to provide the best light. This is true because little money is available for expensive luminaires, as two-fifths had incomes of \$2,999 or less.