

Theme: Elimination of Automatic Censor Lights Which Fail to Light Up at Night

OFFICE LOCATION:	Instrument section, test center, distribution department.		
PRESENTER:	Chosaki Koichi	Circle name:	Double Power
ACTIVITY	October, 1985 through January, 1986 (4 Months).		

LIST OF MEMBERS:	Nakano Hiromu (leader)	Hashizuchi Daihiro	Description of the Circle	The present theme is the 19th since its inception in December, 1980. The young and old all display their potential. Even its name is "Double Power."
	Tanaka Katsuo	Sakai Isamu (transferred in May, 1986)		
	Saito Chieko			
	Nagami Isamu	Matsunura Yoshiro		
	Choseki Koichi	(Joined in May, 1986)		

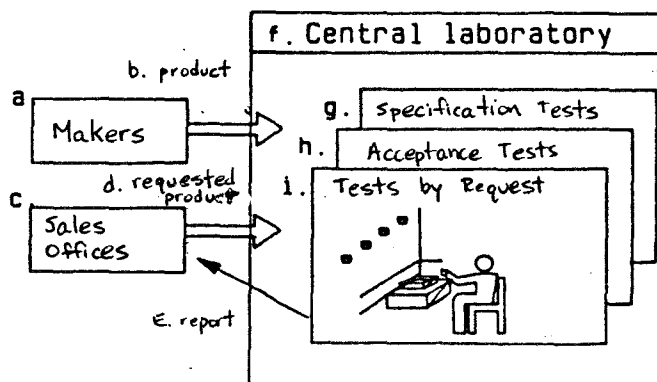
STATUS OF MEETINGS

NO.	1	2	3	4	5	6	7	8	9	AVERAGE
1. MONTH AND DAY	10/7	10/22	11/11	11/26	12/09	12/20	1/13	1/23	1/31	-----
2. TIME	1:50	1:30	2:00	1:50	1:40	1:30	2:00	1:50	1:40	1:46
3. PARTICIPATION RATE	100	100	85.7	85.7	100	85.7	100	85.7	100	93.6

SUMMARY OF ACTIVITIES

IMPLEMENTATION ITEMS	SCHEDULE	PLAN	ACCOMPLISHMENT	SUMMARY OF IMPLEMENTATION
SELECTION OF THEME				1. To clarify the causes for nocturnal illumination failure.
ASSESSING THE PRESENT SITUATION				1. Investigated cases of nocturnal failure.
ANALYSIS				1. Conducted recurrence tests of nocturnal failures. 2. Conducted detailed investigation of relay circuits and on-the-spot examination.
PLANNING AND EXECUTION OF COUNTERMEASURES				1. Instructed to improve installations. 2. Instructions were given concerning instrument fastening by installers and parts modification by manufacturers.
EVALUATION OF EFFECTS				1. Improvement on installation sites was insufficient, falling short of goal. 2. There was no failure that could not be explained.
RESOLUTION AND REFLECTION				1. Assign specific part characteristics as objects of quality control by makers and bring it under constant supervision.

SUMMARY OF WORK

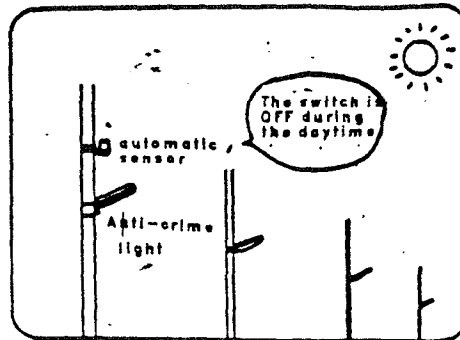


j) The central laboratory is a testing laboratory of the distribution dept. which contributes toward the quality improvement of parts by testing parts and providing the results to sales offices.

Reasons for Choosing the Theme

What is an automatic censor light?

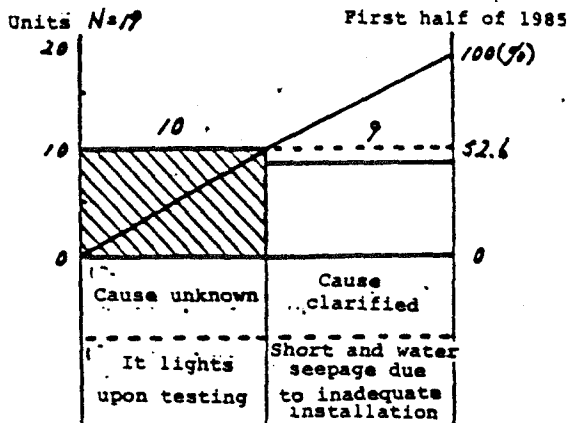
It is an automatic switch that shuts off during the day and turns on the anti-crime lights when evening illumination is lower than 20-5 lx.



The automatic censor that fails to turn on anti-crime lights during the night is called a "non-lighting unit".

(Lab Test Results)

Investigation of automatic censors that lead to non-lighting units



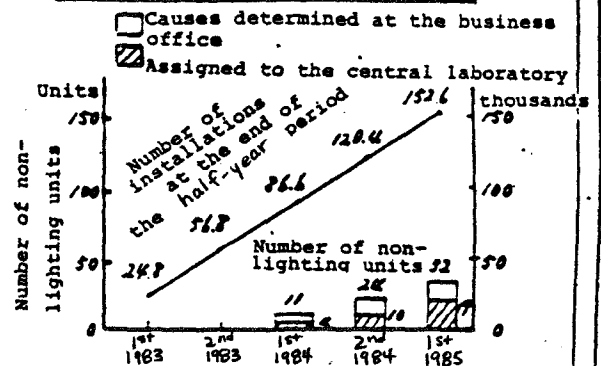
52.6 % of the non-lighting unit cases examined are of unknown causes

Based on the results of investigation, business office is notified of necessary steps



So many cases of unknown cause; it poses quite a problem.

Occurrence of non-lighting units



The number of automatic censor installations in ten years will be 1,440,000 (Increase in the number of anti-crime lights contract, 30,000/year; replacement of old line products, 100,000/year)

The number of non-lighting units increases along with the increase in the number of installations

In ten years, the number of cases with unknown cause will be
 $10 \text{ (units/6 months)} \times 2 \times 1,440,000/152,600 = 190 \text{ (units/year)}$

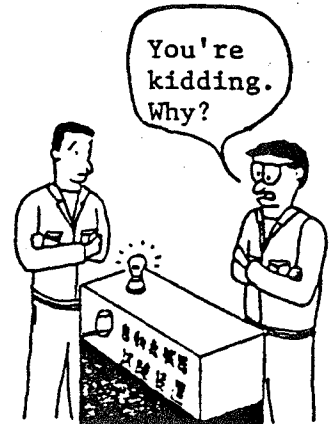
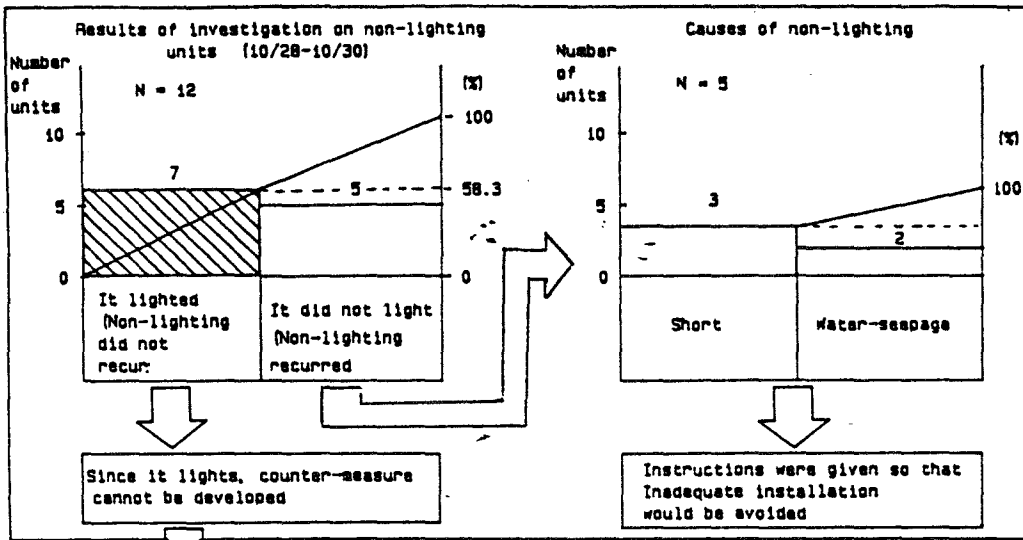
If the present trend continues, there will be 190 non-lighting units each year whose causes are unknown

Objective:

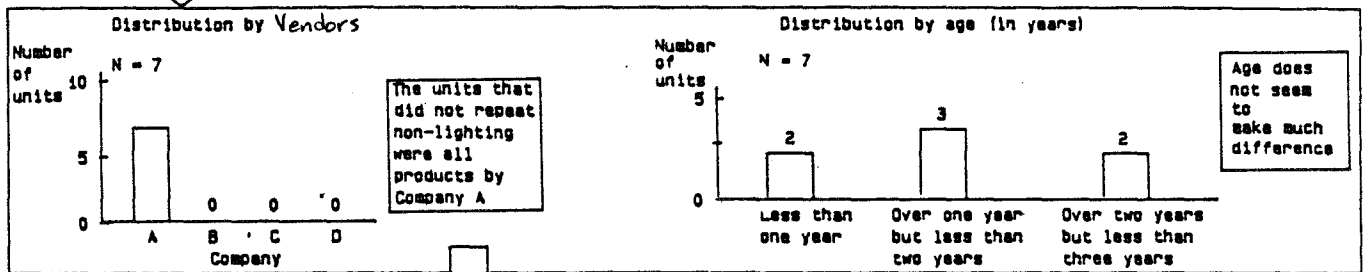
To reduce to zero the number of automatic censors causing failure to light without known cause

Understanding the current situation

Investigation was conducted on 12 units that were brought in over the past three months prior to October, 1985.



Non-lighting did not recur.



It is necessary to find the causes of non-lighting units made by Company A

Analysis 1

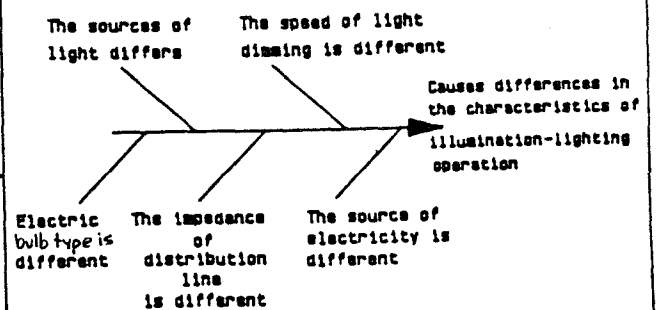
There is no night-lighting at installation sites.

There is normal lighting at the central laboratory.

Of those testing conditions that produce differences between the on-site and the laboratory testings, extract those that are known to be related to non-lighting.

Characteristics causal diagram on "characteristics of illumination-lighting operation.

(Constructed on November 16)



Characteristics of automatic sensors	Relationship to non-lighting
1. Insulating resistance characteristics	×
2. Voltage withstanding characteristics	×
3. Characteristics of illumination-lighting operation	○
4. Characteristics of illumination-turning off operation	×
5. Noise characteristics	×

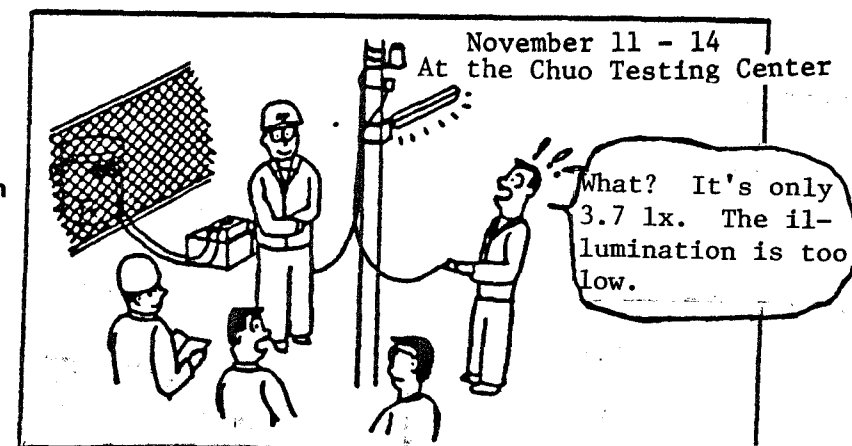
Legend
○: Relationship exists
×: Relationship does not exist

Investigate the effect of each cause on the characteristics of illumination-light operation.

Based upon the orthogonal table below, experiments were designed and implemented because of the existence of many mutually interacting factors.

Characteristics: Lighting illumination (lx)		
Factors	Standard 1	Standard 2
A) Source of light	Standard lamp	Natural light
B) Speed of light dimming	10 lx/min.	1 lx/min.
C) Electric bulb	Incandescent lamp	Fluorescent lamp
D) Impedance of distribution line	0.5	0.1
E) Source of electricity	Electricity room Tr.	Tr. at the top of electric pole

Standard 1
— the central laboratory
Standard 2
— on site condition



Orthogonal table		conditions of experimental repetition					Experimental results
Factors	A B A x C D E	A) Source of light	B) Speed of light dimming (lx/min.)	C) Electric bulb	D) Impedance of distribution line	E) Source of electricity	Lighting illumination (lx)
Column Row	1 2 3 4 5 6 7	1	2	4	5	7	
1	1 1 1 1 1 1 1	Standard lamp	10	Incandescent lamp	0.5	Electricity room Tr	5.4
2	1 1 1 2 2 2 2	Standard lamp	10	Fluorescent lamp	0.1	Tr. at the top of electric pole	3.9
3	1 2 2 1 1 2 2	Standard lamp	1	Incandescent lamp	0.1	Tr. at the top of electric pole	6.1
4	1 2 2 2 2 1 1	Standard lamp	1	Fluorescent lamp	0.5	Electricity room Tr	3.6
5	2 1 2 1 2 1 2	Natural light	10	Incandescent lamp	0.5	Tr. at the top of electric pole	5.5
6	2 1 2 2 1 2 1	Natural light	10	Fluorescent lamp	0.1	Electricity room Tr	3.7
7	2 2 1 1 2 2 1	Natural light	1	Incandescent lamp	0.1	Electricity room Tr	5.6
8	2 2 1 2 1 1 2	Natural light	1	Fluorescent lamp	0.5	Tr. at the top of electric pole	3.7



Analysis of Variance Table
(Examines the effects of each cause)

Factors	Sum of squares	Degree of freedom	Expected variance	Variance ratio
A) Source of light	0.031	1	0.031	2.39
B) Speed of light	0.031	1	0.031	2.39
C) Electric bulb	7.411	1	7.411	570.08 *
D) impedance of distribution line	0.151	1	0.151	11.62
E) Source of electricity	0.101	1	0.101	7.77
A x B Interaction	0.011	1	0.011	0.95
E error	0.013	1	0.013	---
T Total	7.749	7	-----	---

The lighting illumination was sometimes lower than the standard value of 5 lx

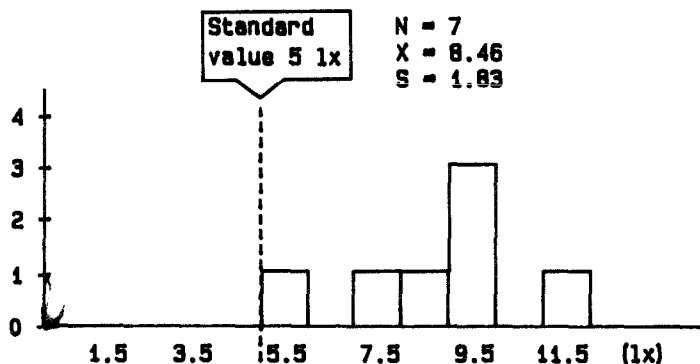
* Significant at 5% level
F (0.05) = 161.0

C (electric lamp) is significant at 5% level, when others are not. Fluorescent lamp results in lower lighting illumination

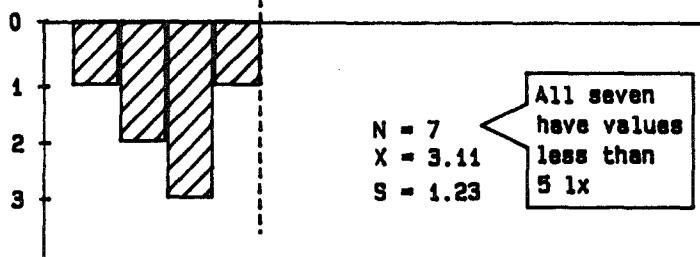
Remaining six units made by Company A are tested under No. 1 and No. 2 conditions

Non-lighting units made by Company A

Experimental condition No. 1
(Incandescent lamp)



Experimental condition No. 2
(Fluorescent lamp)



Hypothesis

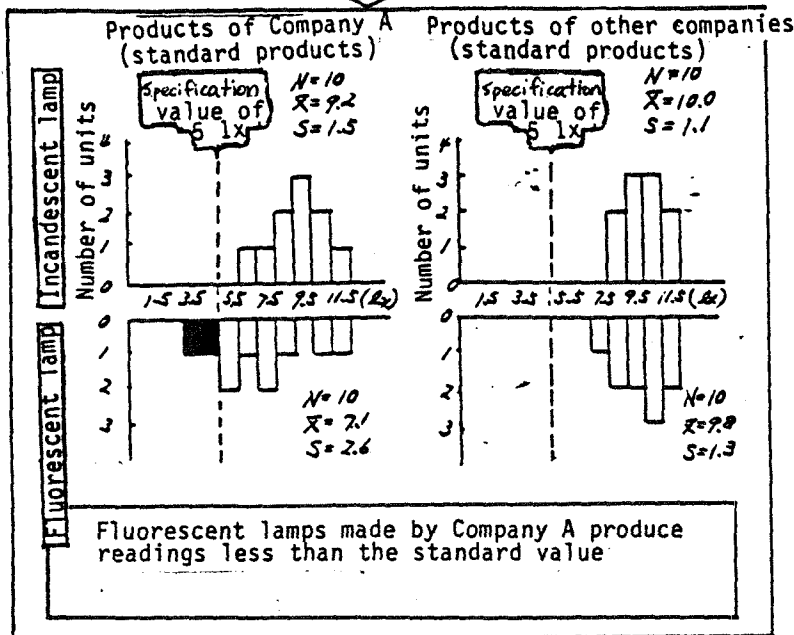
The use of automatic sensor made by Company A and fluorescent lamp in an area with high night-time illumination results in failures, to light at night.

Compare products by Company A and other companies, and investigate night-time illumination.

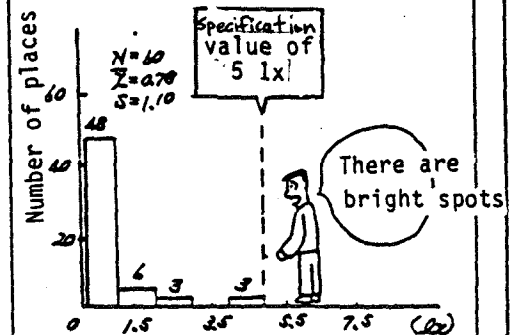
Investigate the changes in lighting illumination as a function of lamp types using products made by Company A and other companies

Conduct experiment under experimental conditions No. 1 and 2

Measure nocturnal illumination in residential areas without anti-crime lighting



Each member of the team conducted measurements at ten different places in his neighborhood



There are some spots that are quite bright

The hypothesis, "the use of automatic censor made by Company A and fluorescent lamp in an area with high illumination results in failure to light at night", has been verified.

Causes are clarified

Countermeasure 1

Made a request to Company A to conduct a detailed study on "lowering lighting illumination using fluorescent lamps"

(November 18)

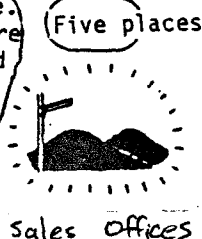
Notified and explained to the sales offices that "automatic censors made by Company A fail to light at night if night-time illumination is high around installation sites," and instructed them to reconsider installation sites

(November 15)

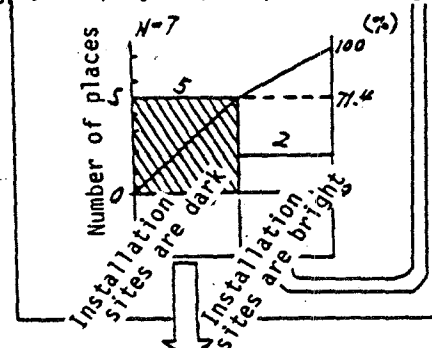


Grasping the effects I

"It is rather strange. Installation sites are in the mountains, and the nocturnal illumination is not high."



Survey of installation sites with non-lighting units made by Company A (Telephone survey)



Reconsider the installation location (direction) of automatic censor (Sales Offices)

Reinstall the non-lighting units

Both non-lighting units are lighted

Non-lighting occurs even when the surrounding illumination at installation sites are low

Unresolved

Resolved

Analysis 2

Although we examined all the causes suggested by past experience, it is still not possible to grasp the causes of non-lighting



Problematic areas (reflection) measures
Lack of technical Knowledge --- study group
Lack in logic --- FT diagram
Insufficient information --- on-site survey

Study group on electronic circuits

(December 2)



FT diagram: "Some automatic sensors made by Company A lead to failure to light at night"

(Constructed on December 3)

Some automatic sensors made by Company A lead to failure to light at night

Relay circuit is not working properly

Relay gate current is too small.

Light receiving circuit is not working

Load impedance is too large.

The sensitivity of light-receiving circuit is low

The voltage of electric source is low

Fluorescent lamp

Insufficient of relay contact

The sensitivity of relay circuit is low

Circuit breaking

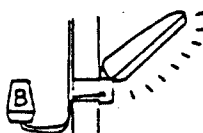
Location	On-site	Laboratory	On-site	On-site	On-site	Laboratory	On-site
Method of investigation	Examine whether there is a source of light in the surrounding areas. Measure the level of night-time illumination in the surrounding	—	Measure the voltage of electricity source (Voltmeter)	Examine the type of lamps (Visual inspection)	Reinstall non-lighting unit and confirm its non-lighting---Lamps are refastened and tested for lighting	—	Circuitry check on the lamp side

Results

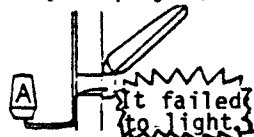
0.3 lx: not bright	7	105 V: not low	Fluorescent lamp	7	Circuitry check: favorable
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(x) Does not emerge as probable cause
(o) Emerge as probable cause

Step 1: Used product made by Company B. It lighted



Step 2: Used product made by Company A.



None of the five units lighted

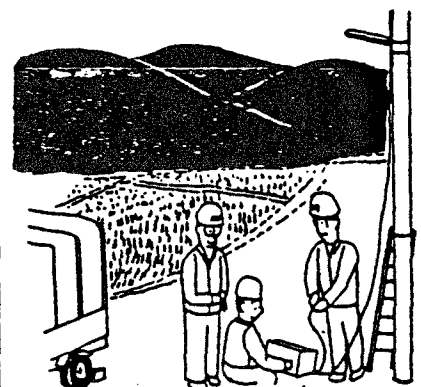
Step 3: Fluorescent lamp and glow lamp were refastened while the Company A product was on.



All five lighted

Fluorescent lamp and glow lamp made the non-lighting units made by Company A to light.

The automatic censor made by Company A is vulnerable to the effects of insufficient connections.

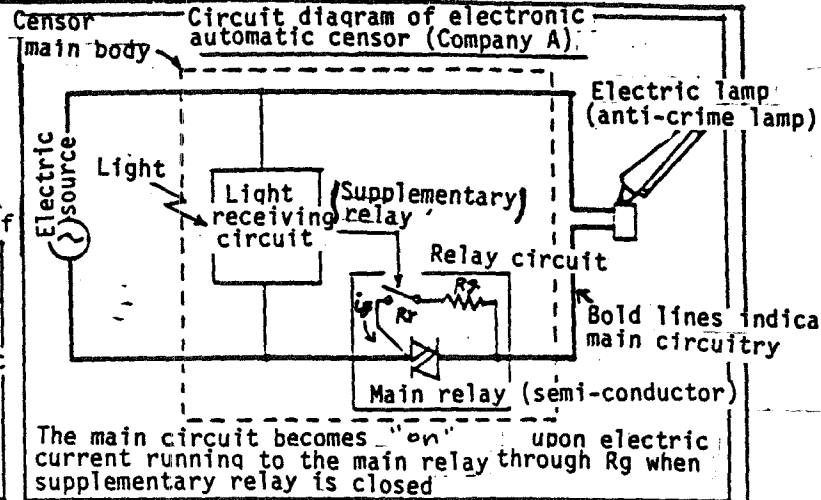


Visit the failure site and conduct on-site test

(December 5)

We examine the reasons for Company A automatic sensors' vulnerability to insufficient contact

Characteristics	Reasons	Sensitivity of light receiving circuit is low	Sensitivity of relay circuit is low
Automatic sensors made by Company A are susceptible to the effects of insufficient contact		Is not related (Light-receiving circuit is in parallel to lamp)	Is related (Relay circuit is in series with lamps)



Measured resistance values of Rr and circuit closing characteristics of the main relay

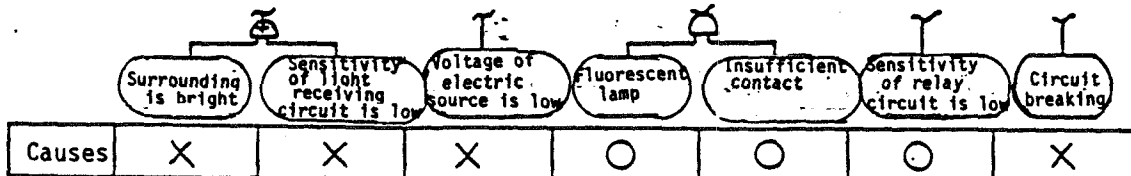
Resistance Rr at the contact of the supplementary relay	Resistance Rg	Voltage and current needed to close main relay
Non-lighting units Number of units 30 50 70 90 Rr (Ω) N=5 $\bar{X}=54.88$ S=18.62 Normal Units N=5 $\bar{X}=57.46$ S=16.74	Non-lighting units Number of units 175 200 225 Rg (Ω) N=5 $\bar{X}=177.34$ S=28.6 Normal Units N=5 $\bar{X}=200.0$ S=20.2	Gate current (mA) Gate voltage Vg (V) Normal Units Non-lighting units Group difference seems to exist
1. Test of equal variance Hypothesis $H_0: \sigma_A^2 = \sigma_B^2$ $\bar{Y}_A = 346.70$ $\bar{Y}_B = 280.23$ $\phi_A = 4$ $\phi_B = 4$ $F_0 = \bar{Y}_A / \bar{Y}_B = 1.24$ $F_0 < F_{\alpha}^*(0.025) = 2.60$ Hypothesis of equal variance is tenable 2. Testing the difference in population means Hypothesis $H_0: \mu_A = \mu_B$ $\bar{X}_A = 57.46$ $\bar{X}_B = 54.88$ $S_A = 1121.2$ $S_B = 1382.5$ $\phi_A = 4$ $\phi_B = 4$ $\hat{\sigma} = \sqrt{\frac{2507.7}{8}} = 17.70$ $t_0 = 0.366 < t(8, 0.05) = 2.306$ Cannot say that there is difference in population means Not related to causes	1. Test of equal variance Hypothesis $H_0: \sigma_A^2 = \sigma_B^2$ $\bar{Y}_A = 8.18$ $\bar{Y}_B = 4.08$ $\phi_A = 4$ $\phi_B = 4$ $F_0 = \bar{Y}_A / \bar{Y}_B = 2.00$ $F_0 < F_{\alpha}^*(0.025) = 2.10$ Hypothesis of equal variance is tenable 2. Testing the difference in population means Hypothesis $H_0: \mu_A = \mu_B$ $\bar{X}_A = 200.0$ $\bar{X}_B = 177.34$ $S_A = 16.34$ $S_B = 3277$ $\phi_A = 4$ $\phi_B = 4$ $\hat{\sigma} = \sqrt{\frac{47.11}{8}} = 2.478$ $t_0 = 0.377 < t(8, 0.05) = 2.306$ Cannot say that there is difference in population means Not related to causes	1. Test of equal variance $H_0: \sigma_{IA}^2 = \sigma_{IB}^2$ $H_0: \sigma_{VA}^2 = \sigma_{VB}^2$ $\bar{Y}_A = 234$ $\bar{Y}_B = 1.28$ $\bar{Y}_A = 277.00$ $\bar{Y}_B = 267.00$ $\phi_A = 4$ $\phi_B = 4$ $\phi_A = 4$ $\phi_B = 4$ $F_0 = \bar{Y}_A / \bar{Y}_B = 2.14$ $F_0 = \bar{Y}_B / \bar{Y}_A = 1.22$ $F_0 < F_{\alpha}^*(0.025) = 2.60$ $F_0 < F_{\alpha}^*(0.025) = 2.60$ Hypothesis of equal variance is tenable 2. Testing the difference in population means $H_0: \mu_A = \mu_B$ $H_0: \mu_{VA} = \mu_{VB}$ $\bar{X}_A = 12.00$ $\bar{X}_B = 17.11$ $\bar{X}_A = 0.77$ $\bar{X}_B = 0.818$ $S_A = 10.356$ $S_B = 5.132$ $S_A = 0.0002$ $S_B = 0.0002$ $\phi_A = 4$ $\phi_B = 4$ $\phi_A = 4$ $\phi_B = 4$ $\hat{\sigma} = \sqrt{\frac{14.08}{8}} = 1.418$ $\hat{\sigma} = \sqrt{\frac{0.0002}{8}} = 0.018$ $t_0 = 4.8012 > t(8, 0.05) = 2.306$ $t_0 = 2.4572 > t(8, 0.05) = 2.306$ For both Ia and Va, there is difference in population means Related to causes

Determine the root causes shown in FT diagram on the basis of investigation

Legend

O: Related to causes;
X: Not related to causes

FT diagram on "Company A's automatic sensors lead to Dec. 3
night-time failure to light" Dec. 12 Revised



Company A's automatic sensors with low relay sensitivity produce nocturnal failure to light when attached to fluorescent lamps with insufficient contact

The second cause is determined

Measure 2

Instructions were issued to "Refasten anti-crime fluorescent lamps and glow lamps and test the operation when night-time failure to light occurs with Company A's automatic sensors"

(Distributed December 16)

2. Made request to Company A to "
(semi conductor relays)"

(December 18)

Company A studied the situation and determined that the design of the relay is not appropriate.

The central laboratory Company A improved products with the following modifications

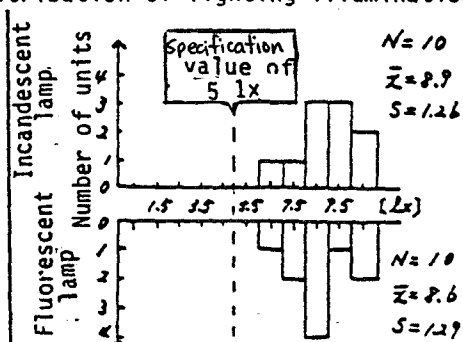
(Measure 1)
To reduce the level of illumination --- modification in the design of light receiving circuitry
(Measure 2)
To cope with the insufficient sensitivity --- changes in the design of relays of main relay

Conducted recurrence experiment on improved products

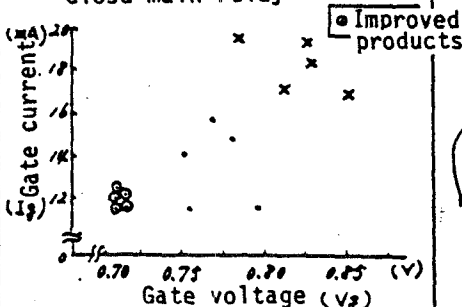
(Jan. 23-24)

Transported 10 improved units to the central laboratory

Distribution of lighting illumination



Voltage and current needed to close main relay



It was confirmed that with improved products there was no nocturnal failure to light.

