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16. Abstract One aspect of the control of hazardous cargo is to ensure that trucks carrying such cargo travel on approved routes. These routes, once chosen, should be clearly marked as permitted routes; conversely, routes not allowing hazardous material movement should be marked with prohibitory signs. This study evaluated six candidate signs in both prohibitory and permissive versions. Truck drivers and members from the general driving public participated in the study. Signs were evaluated as to their meaning, legibility, recognition time and likelihood of confusion with other selected symbol signs. Subjects also ranked the candidate signs according to preference. Overall, the study concludes that a symbol consisting of the capital letter HC inside a green (permissive) or red (prohibitory) ring designating permissive or prohibitory routes respectively was, on balance, the most effective sign across the measures utilized in the study.			
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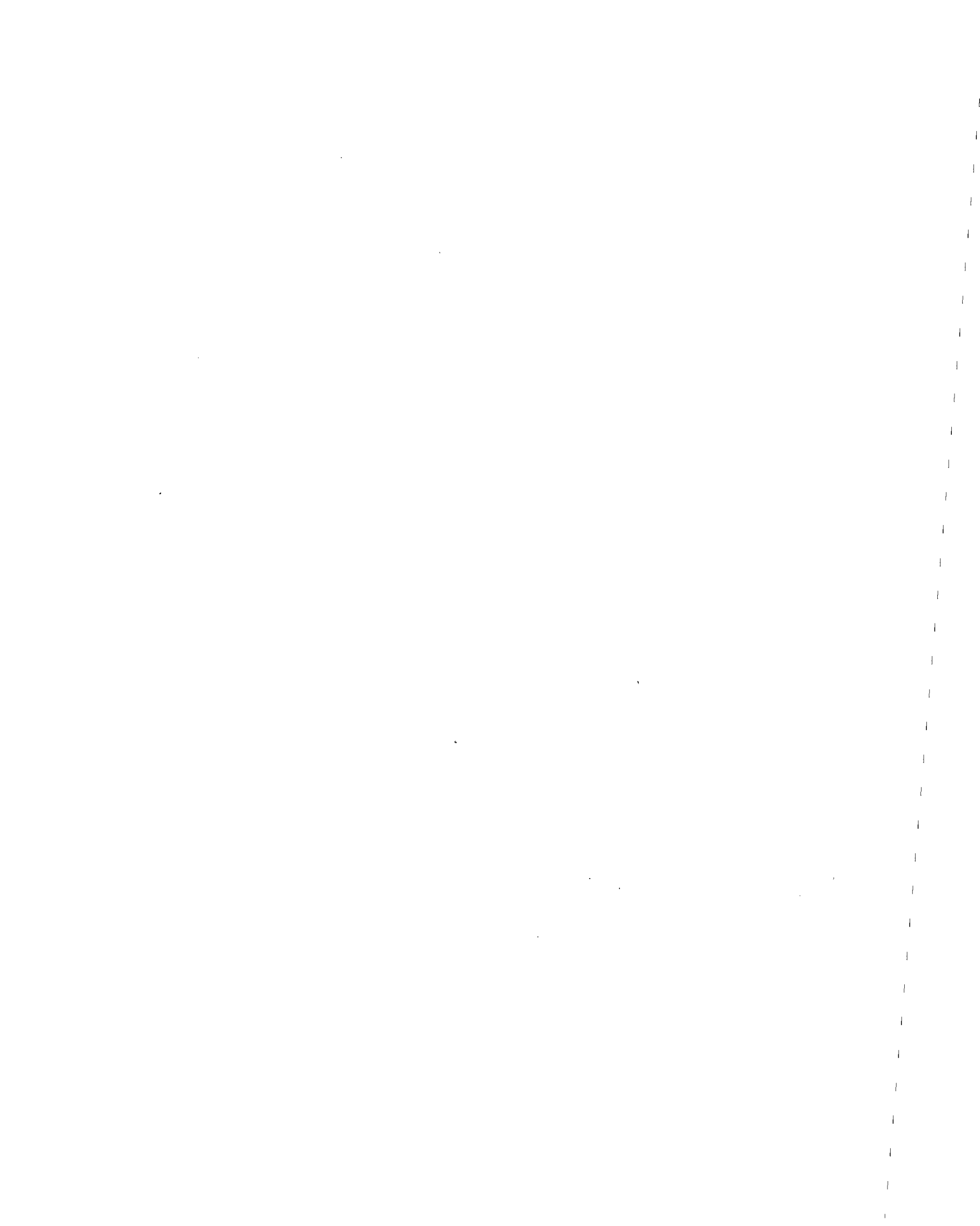
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AN EVALUATION OF CANDIDATE SYMBOLIC ROUTING SIGNS
FOR TRUCKS CARRYING HAZARDOUS CARGO

Introduction

One aspect of the control of hazardous cargo, such as petroleum products, hazardous chemicals, toxic wastes, explosives, and radioactive materials, is to insure that the trucks carrying such cargo travel on approved highways. Once these highways have been chosen they must be clearly marked. Likewise, those routes on which hazardous cargos are prohibited must also be clearly marked. The FHWA made uniform hazardous material signing "Candidate action one" in its position paper on "Transportation of Hazardous Materials" (1). Two studies (2, 3) have previously recommended signs for this purpose.

Dewar (2) investigated symbol signs (containing no verbal message) and recommended a black diamond, surrounded by a green circle in the permissive version or by a red circle with a slash in the prohibitory version. He felt the other symbols, which were truck variations, were either too easy to confuse with the standard 'No Truck' symbol or were too hard to see.

McDonald (3) started with a large array of signs which were reduced to six through a preliminary survey. Five out of the six were side views of trucks, four of them had the letters HC either on a flat bed, on a large diamond, on a large disc, or on a rectangle on the bed, while the last side view portrayed an explosion on a flat bed. The sixth sign was a rear view of a truck with the letters HC on the upper part of the trailer. McDonald recommended the flatbed truck with the letters HC on it.

When comparing the two, the National Committee on Uniform Traffic Control Devices recommended the sign with the black diamond. The present research was undertaken to further investigate the possibilities. Aside from the two signs recommended by Dewar and McDonald, four others were designed for this study. Two separate experiments were conducted, one measuring meaning and preference, the other measuring visibility and preference.

EXPERIMENT 1: MEANING AND PREFERENCE

Subjects

There were 107 paid volunteers in this experiment. Of these, 26 were truck drivers and 81 were from the general public, mostly students and faculty from a small southeastern college. The truck drivers were recruited at a 'trucks-only' rest area on I-95 near Woodbridge, Virginia, and at the truckers' restaurant in the Servicetown truck stop near Fredericksburg, Virginia. None of the subjects from the general public were truck drivers.

Comparing the two groups, the average age of the truck drivers, 36.3, was significantly higher than that of the other group, 22.4, ($t = 6.0$, $df = 105$, $p < .001$). Also, the gender distribution was different in the two groups (Chi-square = 9.9, $df = 1$, $p < .01$). Only 4 of the 26 truck drivers were female, whereas 43 of the 81 subjects were female in the other group.

However, the groups did not differ in terms of driving habits in their cars, i.e., averages for miles driven per week ($t = -0.6$, $df = 100$, n.s.), number of accidents ($t = 0.0$, $df = 25$, n.s.), and number of moving violations ($t = -.01$, $df = 25$, n.s.) were approximately the same for both groups.

Apparatus

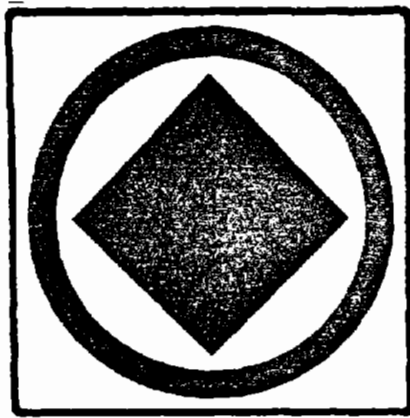
All signs used in both experiments were composed on a computer graphics system (New England Technologies). The results were photographed for slides, and prints were developed from the slides. For experiment 1, the prints were color-Xeroxed. The color copies were then inserted into booklets. This system was used so the order of presentation could be randomized for each subject, with the added benefit that each subject could work at his or her own speed. The colored inserts were removed and reused. See Appendix 1 for a copy of the booklet without the inserts. Also included in the booklet are the informed consent sheet and the instructions. The last page of the booklet showed either all six permissive or all six prohibitory signs, with the order of presentation randomized every five booklets.

The signs used in this study were: 1) the black diamond (DIA) from Dewar's study (2); 2) the flatbed truck with the letters HC on it (THC) from McDonald's study (3); 3) a close-up of a truck showing part of the cab and part of the trailer with a white diamond on the trailer and a black HC inside the diamond (CLO); 4) a symbol similar to the radiation symbol except that it had two vertically aligned fins instead of three fins, and had an H on the left and a C on the right (SYM); and two modifications of a sign being used by the District of Columbia (D.C.). The original DC sign had a red disk on a white square with the white letters HC. Since the use of red is restricted to the ring and slash for this type of sign, one version 5) used a black disk and white letters HC (BHC); and another version 6) used black letters on the usual white background (WHC). See Figure 1 for the permissive versions of the six candidates.

Twelve other signs were used as distractors. Eleven were MUTCD signs: no left turn (R3-2), no U-turn (R3-4), restricted lane ahead (R3-10); keep right (R4-7); do not enter (R5-1); no trucks (R5-2); no parking (R7-2a); winding road (W1-5); pavement width transition (W4-2); narrow bridge (W5-2a), and hill (W7-1). The twelfth distractor sign was a candidate oversized-truck route sign in either a prohibitory or a permissive version.

Procedure

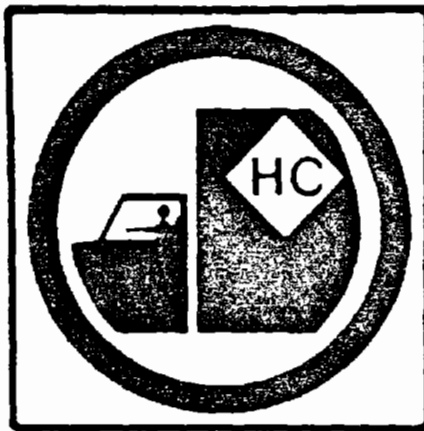
After filling out the consent form and biographical information in the booklet, the subjects wrote what each of the 18 signs meant to them and what effect it would have on their driving. Then they read a page which explained the intended meaning of the signs, and on the last page they recorded their preferences, ranking all six signs from 1 (best) to 6 (worst). Subjects usually completed the booklets at a table and were paid when they handed in the booklet.



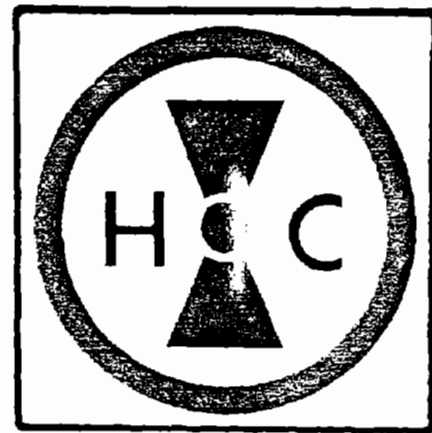
1) DIA



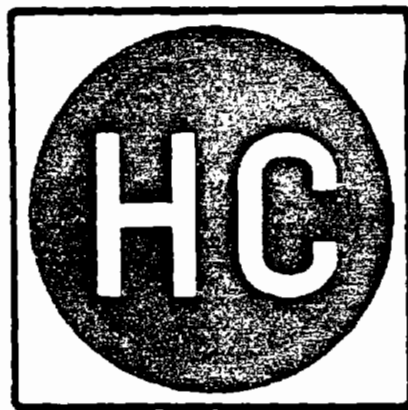
2) THC



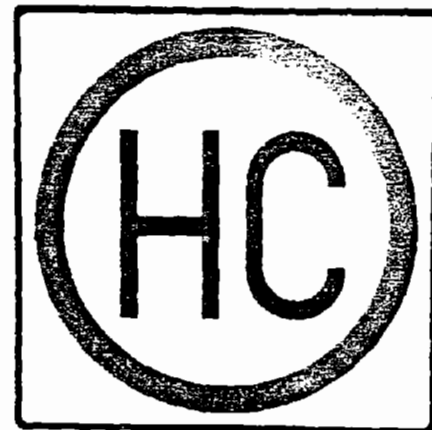
3) CLD



4) SYH



5) BPC



6) MHC

Figure 1. Permissive versions of the six candidate signs. The ring would be green. In the prohibitory version, the ring would be red and a red slash would be added.



Results

The subjects' answers were coded for whether they mentioned 'hazardous cargo', 'truck', 'permissive or prohibitory', and 'route'. An answer was not considered complete unless it included all of these aspects. In addition, a record was kept of misinterpretations of the letters HC, the diamond, and the ring. The original coding matrix had sparse cell numbers so the answers were recoded into 'completely wrong', 'partially correct', or 'completely correct'. Since the patterns of meaning scores were similar for the truck drivers and non-truck drivers, these two groups were combined. Breakdowns of the data by type of message (permissive vs prohibitory) and type of symbol were analyzed separately (see Table 1).

Table 1. Breakdowns of message and type of sign by correctness of answer.

a. MESSAGE			
Type of answer	Prohibitory	Permissive	Totals
Completely wrong	90	149	239
Partially correct	145	135	280
Fully Correct	80	43	123
Totals	315	327	642

b. TYPE OF SIGN.							
Type of answer	DIA	THC	CLO	SYM	BHC	WHC	Totals
Completely wrong	74	25	24	34	39	43	239
Partially correct	29	54	55	46	49	47	280
Completely correct	4	28	28	27	19	17	123
Totals	107	107	107	107	107	107	642

Both Chi-square analyses were significant. More prohibitory signs were fully correct than permissive signs, and conversely, more permissive signs were completely wrong than prohibitory signs (Chi-square = 25.8, $df = 2$, $p < .01$), perhaps because the green ring was so unfamiliar.

Looking at the sign variable, THC and CLO were least likely to elicit answers that were completely wrong, perhaps because they were concrete representations of trucks, and DIA was most likely to be completely wrong. None of the subjects from the general population and only four truck drivers interpreted that sign completely right (Chi-square = 73.2, $df = 2$, $p < .01$). On the other hand, THC, SYM, and CLO were most likely to elicit completely correct answers.

There were over a hundred misinterpretations of the letters HC, with some subjects giving more than one misinterpretation (see Table 2). Some of the more bizarre answers included 'health clubs', 'horse carriers', and 'helicopter crossing'. 'Heavy cargo' was the most frequent misinterpretation with 19 occurrences. The words 'heavy', 'high', and 'highway' occurred frequently for the H, and the words 'carrier', 'crossing', 'chemical', and 'cargo' occurred frequently for the C.

Of those people who offered an explanation for the black diamond, 67 misinterpreted it with no common misinterpretation although some of the more frequent were 'don't block intersection', 'do not enter', 'danger ahead', 'post no signs', and 'no squares' (see Table 2).

Table 2. Most frequent interpretations of the letters HC and the black diamond. Not all misinterpretations are listed.

a. letters HC	Non-Truckers Frequency	Truckers Frequency
Heavy cargo or carriers	23	1
Helicopters	8	0
Hydrochloric acid	6	0
Handicapped	4	1
High clearance	3	4
Heavy construction	2	2
Highly contaminated	4	0
Hospital crossing or cars	6	0
Highway ...	5	0
b. black diamond		
No squares or boxes	10	0
Don't block intersection	5	1
Information sign	0	3
Post no signs	2	1
No traffic signs posted ahead	0	2
Danger ahead	5	0
Explosives	0	2
Do not enter	3	0
Helicopter launching pad	3	0
No through street	2	0
No parking	2	0
No stopping	2	0
Stop ahead	2	0

There were also confusions about the meaning of the color of the ring. Seventeen subjects from the general public and three truck drivers wrote a prohibitory answer while looking at a permissive sign.

The final task for these subjects was to select their preferences among the six signs. The results of Friedman tests on the data were extremely

significant (see Table 3). CLO was selected as best and DIA as worst by both groups.

Table 3. Means of preference rankings for candidate signs: 1 = best, 6 = worst.

	TYPE OF SIGN						Friedman Chi-square (df = 5)
	1) DIA	2) THC	3) CLO	4) SYM	5) BHC	6) WHC	
Truck drivers (N = 26)	5.19	3.15	2.08	2.88	4.19	3.50	43.6 (p < .001)
General public (N = 81)	5.81	2.28	2.17	3.53	3.86	3.33	202.7 (p < .001)

EXPERIMENT 2: VISIBILITY AND PREFERENCE

Subjects

Subjects in the visibility experiment were paid volunteers recruited from a list of subjects who had participated in previous experiments at the Turner-Fairbanks Highway Research Center in McLean, Virginia. There were 15 males and 15 females, ranging in age from 17 to 62, with an average for the group of 31 years. All subjects had their vision tested on an Ortho-Rater to ensure corrected visual acuity of 20/33 or better. The average for this group was 20/20.

Apparatus

The signs used in Experiment 2 were identical to those used in Experiment 1 except that the subjects saw prints and projected slides instead of color-Xerox copies. The slides were rear-projected onto a translucent screen by Kodak Ektagraphic II slide projectors, Model AT. The size of the projected image was 2.38 inches on each side, which resulted in glare in the image, even on the 'low' setting on the projector. Variac transformers were used to reduce the voltage to the projectors thus reducing the glare.

Subjects viewed 5 X 7 inch prints of the six candidate signs while listening to the intended meaning of the signs before the second part of this experiment and while ranking the signs during the third part of the experiment.

Procedure

After the subjects' vision was tested and their biographical data and consent forms were collected they were taken to tunnels approximately 12 X 12 X 120 feet, with florescent lights mounted on one wall and a projector at one end. The first part of the instructions was read to the subject, asking him/her to walk toward the projected sign until he/she could identify any feature on the sign. The experimenter recorded the feature and the distance at which it was

identified, then the subject repeated the procedure until all the major features of each sign had been identified. See Appendix 2 for a score sheet. Each subject looked at the six candidate signs in this manner. Half the subjects saw the permissive versions (green ring) and the other half saw the prohibitory versions (red ring with red slash). The order of presentation of the signs was randomized for each subject.

After the subject had completed this section, the intended meaning of the signs was explained to him/her, and he/she was given the prints to become familiar with them. He/she was then shown 18 slides, the 6 candidate signs plus the 12 distractor signs described in Experiment 1. If the subject saw the permissive versions of the HC route signs, he/she also saw the permissive version of the oversized-truck route sign, and similarly for the prohibitory versions. The task in this phase was simply to identify the sign. The distractors were chosen as the MUTCD signs most likely to be confused with the candidate signs, and the instructions were written to encourage the subject to guess the signs' meanings at the farthest point from the screen so as to maximize the occurrence of confusions among signs. The experimenter recorded all confusions, the distance at which they occurred, and the distance at which the subject correctly identified the meaning of each sign. Once again, each subject saw only permissive or prohibitory candidate signs and the order of all signs was randomized for each subject except that the oversized-truck route sign never appeared after all the candidate signs.

The last section of this experiment was a preference test, as in Experiment 1, except that these subjects arranged prints on a stand from best to worst instead of writing numbers beside the pictures as in Experiment 1.

Results

The summary statistics for the identification-of-features data are given in Tables 4 and 5. Not surprisingly, the average distance at which a feature could be identified was positively correlated with its size. Using the major dimension (diameter for circles and diagonal for rectangles), the correlation coefficient was .91 ($df = 27$, $p < .001$). Considering the pictographic elements that differentiated the signs (the letters HC for signs THC, CLO, SYM, BHC, and WHC; the truck for THC and CLO; the symbol for SYM; and the diamond for DIA and CLO), the diamond on DIA was most visible although the white HC on BHC was very close. The flatbed truck on THC was least visible of all, in fact the letters on the truck were easier to see than the truck.

Table 4. Means and standard deviations for legibility distances (in feet), broken down by feature and sign but not by message (prohibitory vs permissive). Sample sizes (N) differ because not all subjects mentioned all features.

Feature	TYPE OF SIGN						
		1) DIA	2) THC	3) CLO	4) SYM	5) BHC	6) WHC
Shape of Sign (Square)	M	105.24	95.28	100.59	103.86	100.23	101.10
	SD	13.18	29.00	19.47	14.19	21.89	19.14
	N	29	29	29	29	30	28
Color of Sign (White)	M	105.47	94.73	104.62	102.38	100.76	100.10
	SD	11.65	29.94	16.39	21.31	23.66	25.55
	N	30	30	29	29	29	29
Presence of Ring	M	44.97	54.86	51.14	48.06	41.45	53.64
	SD	10.06	14.91	16.06	13.37	22.16	16.13
	N	30	28	29	29	29	30
Color of Ring	M	36.60	45.76	43.30	40.45	42.00	47.10
	SD	15.22	20.19	20.27	17.81	22.45	20.07
	N	30	29	30	29	29	30
Letters H & C*	M	--	17.57	12.90	26.90	49.03	41.13
	SD	--	7.27	4.94	7.88	18.51	12.89
	N	--	30	30	30	30	30
Diamond (For Col 1 & 3) or Symbol (For Col 4)	M	51.77	--	15.72	26.53	--	--
	SD	20.97	--	6.22	9.86	--	--
	N	30	--	29	30	--	--
Truck	M	--	16.93	18.03	--	--	--
	SD	--	6.58	12.85	--	--	--
	N	--	30	29	--	--	--

*Both distances were recorded although subjects almost always identified both letters from the same point. Data shown are for the letter H. None of these were significantly different from the data for letter C. Of five t-tests comparing the averages for H and C, the largest t-value was 1.0 (df = 29, n.s.).

Investigation of differences between the prohibitory and permissive versions of the signs, as far as the visibility of the features was concerned, uncovered few significant differences (see Table 5). The letters HC in BHC and WHC could be identified at a significantly longer distance with the green ring, but the differences were not significant in THC, SYM, or CLO. With DIA, the ring in the prohibitory version was more visible than the ring in the permissive. This is probably due more to the color than to the ring and slash, since the red color was more easily identified than the green for every sign. It is notable that there were so few differences between the two versions.

Table 5. Comparison of means of legibility distances (in feet) by message, feature, and sign. Sample sizes differ in some cases because not all subjects mentioned all features. R indicates the prohibitory message (red ring and slash), and G indicates the permissive message (green ring).

Feature	TYPE OF SIGN							Average
	1) DIA	2) THC	3) CLO	4) SYM	5) BHC	6) WHC		
Shape of Sign (Square)	G	103.14	89.93	93.86	104.43	102.60	94.14	97.13
	R	107.20	100.27	106.87	103.33	97.87	108.07	103.59
Color of Sign (White)	G	102.13	93.60	99.87	101.21	105.36	100.79	100.14
	R	108.80	95.87	109.71	103.47	96.47	99.47	102.19
Presence of Ring	G	41.27*	53.31	51.21	44.71	35.36	51.86	46.46
	R	48.67	56.20	51.07	51.20	47.13	55.43	51.69
Color of Ring	G	25.20**	36.80*	35.60*	32.40**	32.53*	41.40	33.99**
	R	48.00	55.36	51.00	49.07	52.14	52.80	51.57
Letter H	G	--	20.00	13.40	27.33	58.00**	46.93*	33.13*
	R	--	15.13	12.40	26.47	40.07	35.33	25.88
Letter C	G	--	19.47	13.40	27.87	58.00**	46.40*	33.03*
	R	--	16.13	12.40	26.47	41.13	35.87	26.40
Diamond	G	57.60	--	16.33	--	--	--	36.97
	R	45.93	--	15.07	--	--	--	32.00
Truck	G	--	18.67	20.40	--	--	--	19.53
	R	--	15.20	15.50	--	--	--	15.40

Significance of differences between permissive and prohibitory versions:

* $p < .05$

** $p < .01$

In the second phase of Experiment 2 the subjects knew the meaning of the candidate signs and were supposed to identify them and 12 other signs from as far away as possible. This yielded two types of data: distances for correct identifications and confusions for incorrect identifications. The distances for the correct identification of the candidate signs were analyzed with a 2 X 6 (message by type of symbol) analysis of variance, with type of symbol being a within subjects variable. There were rather large differences among symbols but no significant differences between the means for the permissive and prohibitory messages. See Table 6 for means and Table 7 for the analysis of variance summary table.

Table 6. Means for recognition distances for the six candidate signs.

Message	TYPE OF SIGN						Total for Message
	1) DIA	2) THC	3) CLO	4) SYM	5) BHC	6) WHC	
Permissive	48.87	34.13	37.33	48.87	61.67	50.00	46.81
Prohibitory	47.79	28.21	36.87	40.07	53.27	44.20	41.82
Total for Sign	48.35	31.28	37.10	44.47	57.47	47.10	

Table 7. Analysis of variance summary table for distances (in feet) at which subjects correctly identified the sign.

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	<u>p</u>
Total	64,028.10	177			
Between Subjects	32,249.60	29			
Message	1424.03	1	1424.03	1.29	n.s.
Error Between	30,825.57	28	1100.91		
Within Subjects	32,542.56	148			
Sign	12,932.22	5	2586.44	18.60	<.001
S X M	419.33	5	83.87	0.60	n.s.
Error Within	19,191.01	138	139.07		

Table 6 shows that sign BHC was recognized at the farthest distance. Post-hoc tests on the type-of-sign variable showed that the average for BHC was significantly greater than all other signs, and the averages for the "truck" signs, THC and CLO, were significantly less than most of the others.

As a test of the validity of obtaining recognition distances by this method, data from this study were compared to a controlled field study (4) which used full-sized signs and a closed road. Three signs were identical (No Trucks, No U Turn, and Winding Road) and a fourth (No Right Turn) was deemed to be close enough to the No Left Turn sign used in this study to allow a valid comparison. The correlation between the studies, using the identification distances for these four signs, was 0.99, almost perfect. Although the distances were shorter in the present study because of the smaller stimulus

size, the visual angles for the signs were on the same order of magnitude: an average of 0.23 degrees for this study compared to an average of 0.18 degrees for the other study (4). The differences, although small, are statistically significant ($t = 7.0$, $df = 3$, $p < .01$), partially due to the high correlation. A possible reason for the difference is that the subjects in the field study (4) were shown the signs beforehand while in this study the distractor signs were not shown beforehand. In any case, the high correlation between the two studies is evidence that this method corresponds to on-the-road identification.

Over all 30 subjects, only 8 confused any signs, and the total number of confusions was only 15. Of these, 7 involved the THC symbol, 2 involved the DIA symbol, CLO and WHC had one confusion apiece, and the rest of the confusions did not involve the candidate signs.

The final task for these subjects was to arrange the six signs in their order of preference. This data also had very significant differences in the means of the rankings (see Table 8). As in Experiment 1, DIA was the least favored, but this group preferred the signs with only the large HC (WHC and BHC in that order), whereas the previous group preferred the truck symbols (THC and CLO). A possible explanation is that this group saw first-hand how difficult the small detail in the truck signs could be to see.

Table 8. Means of preference rankings for candidate signs: 1 = best, 6 = worst. The results from the same task in Experiment 1 are included for comparison.

	TYPE OF SIGN						Friedman Chi-square ($df = 5$)
	1) DIA	2) THC	3) CLO	4) SYM	5) BHC	6) WHC	
Subjects from Experiment 2 (Visibility) (N = 30)	4.56	3.77	3.40	3.17	3.13	2.97	15.0 ($p < .05$)
Subjects from Experiment 1 (Meaning)							
Truck drivers (N = 26)	5.19	3.15	2.08	2.88	4.19	3.50	43.6 ($p < .001$)
General public (N = 81)	5.81	2.28	2.17	3.53	3.86	3.33	202.7 ($p < .001$)

Discussion

There is no symbol which is best over all the measures. Dewar's diamond symbol (DIA) was visible at the longest distance to naive subjects and had the second best recognition distance after the subjects became familiar with the symbols and their meanings. On the other hand, it was preferred the least by all subjects and was the worst when naive subjects tried to assign a meaning to it.

McDonald's symbol (THC) was one of the best as far as naive subjects assigning meaning was concerned and had a high preference rating according to subjects in the meaning experiment. However, it was one of the worst as far as visibility and recognition distances were concerned, and had more confusions than any other symbol during the recognition task.

The symbol of a close-up of a truck (CLO) had a pattern of results similar to McDonald's symbol (THC). It fared well in the meaning study but poorly in the visibility and recognition studies. The only notable difference between CLO and THC is that CLO showed fewer confusions in the recognition task.

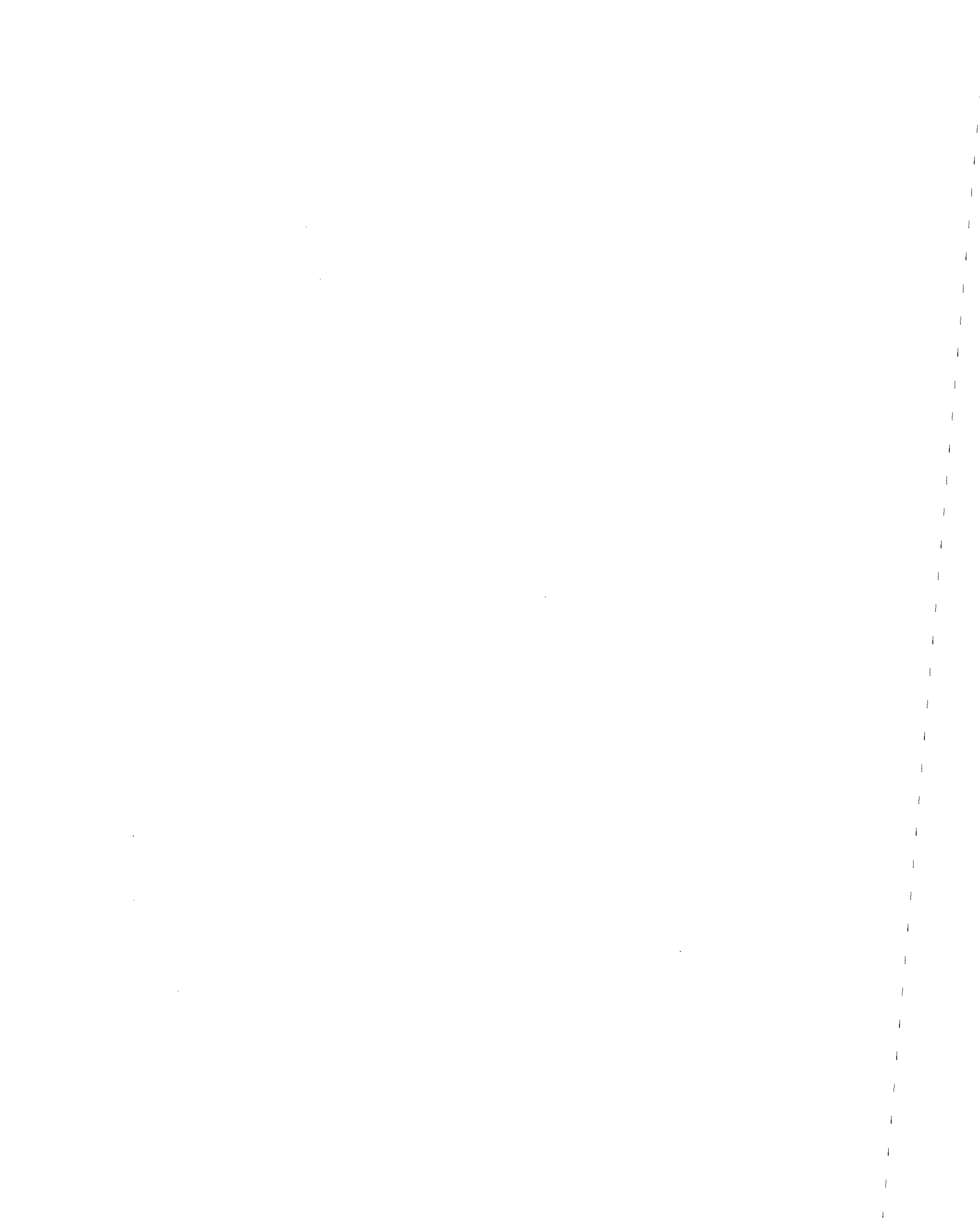
The symbol that looked somewhat like the radiation symbol (SYM) ranked about in the middle on all the scales. Truck drivers were especially likely to associate it with the radiation symbol and liked it for that reason.

The two variations of the District of Columbia (D.C.), sign (BHC and WHC) fared very well in Experiment 2 (Visibility and preference). BHC had the best recognition distance of all the signs, both had good visibility distances, and both were rated highly in the preference section of that experiment.

Because no symbol ranked high on all the dimensions of interest, any recommendation will depend on the relative weights given to each factor. The ability of the symbol to communicate to the unfamiliar viewer is usually a primary concern. However, this sign is intended for a special target group: truck drivers transporting hazardous cargo. For this reason, comprehension by naive viewers may be less critical. The major concern is that the general public does not seriously confuse the sign meaning with some other message. Overall, very few confusions were made even though the instructions to the subjects were written so as to maximize confusions. If any sign were to be eliminated because of this consideration, it would be THC, the sign recommended in McDonald's study (2).

Another related concern is that the sign can communicate to viewers that are not English-speaking. Again, the special target group probably gives this factor less weight than might be appropriate for the general driving public. This makes the use of alphabetic characters (HC) more acceptable.

Whatever decision is made on the choice of symbol, it should be noted that the green ring in the permissive version of the sign causes problems for a significant portion of drivers, both truck drivers and non-truck drivers alike. Over 20% of the subjects interpreted the green ring as "prohibitory." This is consistent with results from another recent study (on truck route symbols) from this laboratory. An effective educational campaign would be needed if this symbol is used. Alternatively, the green ring could be dropped, which would allow more space for the letters or symbols.



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2. Evaluation of Dangerous Goods Route Symbols. Dewar, R. E. Road and Motor Vehicle Traffic Safety Branch, Transport Canada, June, 1982.
3. Development of a Hazardous Materials Routing Sign. Final Report. McDonald, C. FHWA/RD-82/141, March, 1983.
4. Methods for the Evaluation of Traffic Signs. Final Report. Dewar, R. E. and Ells, J. G. Submitted by Institute for Transportation Studies, The University of Calgary, to Ministry of Transport, Ottawa, Canada, June, 1974.



HIGHWAY SYMBOL SIGN EVALUATION STUDY

Conducted by

THE FEDERAL HIGHWAY ADMINISTRATION RESEARCH CENTER

The purpose of this study is to determine the effectiveness of a sample of highway signs that use symbols rather than words. On the following pages you will find two signs each, with space for 1) The meaning of the sign or the name of the sign; and 2) The effect the sign would have on your driving, such as: watch your speed, slow down, look for cars coming onto the highway, keep an eye out for bicycles, etc., whatever you think would be appropriate when you saw that sign. Some of these answers will be conditional, such as, "If I needed gas I could pull off at the next exit and buy some," would be an appropriate answer for a sign with a gas pump. Note: I have included some new signs and some that are rarely used. Please take a guess even if you don't know for certain what the sign means. It's very important that I have an answer for each sign. Thank you for your time and effort. Please fill out the information at the bottom, read the examples on the first page, and go ahead. Please do not look ahead at the other signs, although I don't mind you looking back at the ones you have completed. Especially do not look at the last page until you get there.

Date _____

ID # _____

AGE _____

SEX _____

How many miles a week do you drive in your car? _____

How many accidents in your car in the last 5 years? _____

How many moving violations in your car in the last 5 years? _____

FOR PROFESSIONAL TRUCK DRIVERS ONLY

Please answer the last three questions with regard to your truck driving.

A-1

Miles a week? _____

Accidents? _____

Meaning: Deer Crossing Sign

or

Deer sign

or

Deer ahead

or

Look out for deer

Action: Slow down, maybe, be alert for
deer on the side of the road.



Meaning: Phone Sign

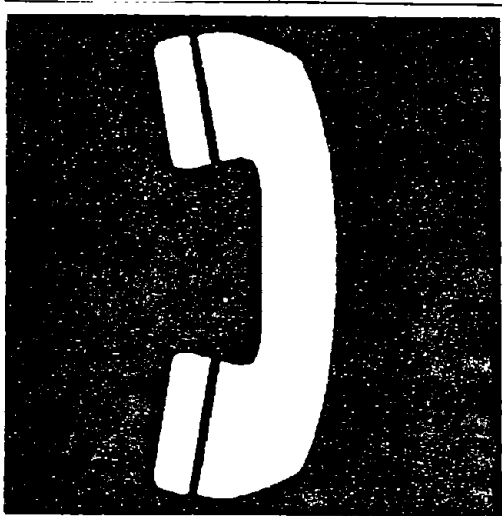
or

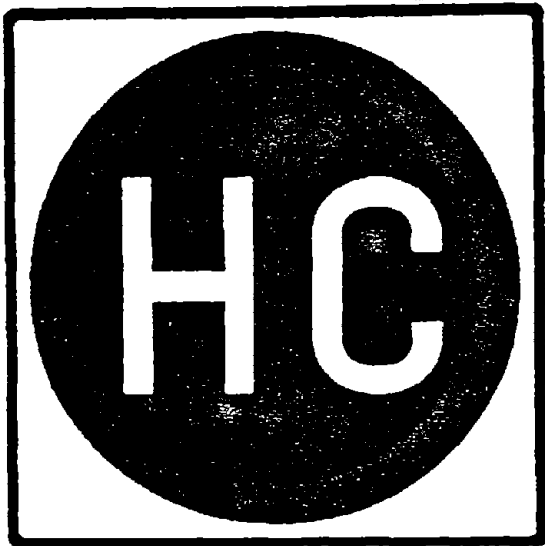
Phone Ahead

or

Phone at next exit

Action: If I needed a phone, I'd know
there was one at the next exit, and
I should slow down and look for the
exit sign.





Meaning: _____

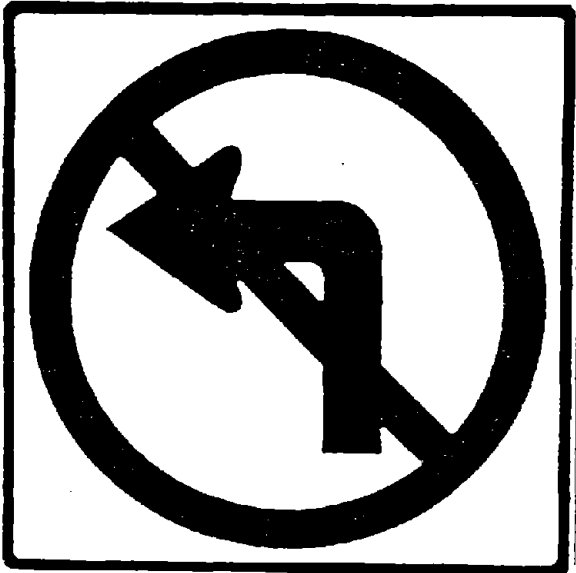
Action: _____



Meaning: _____

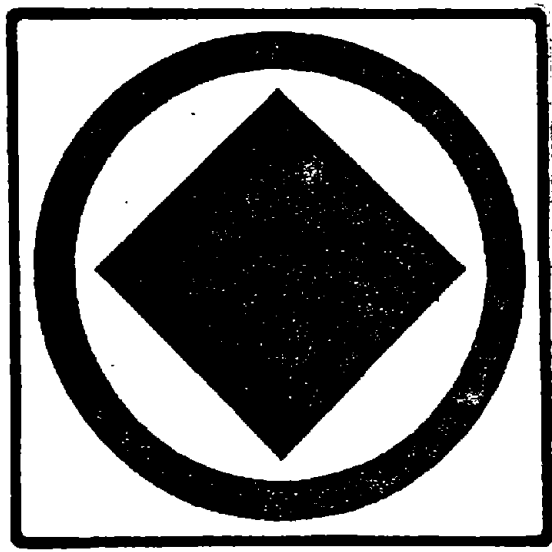
Action: _____

Meaning: _____



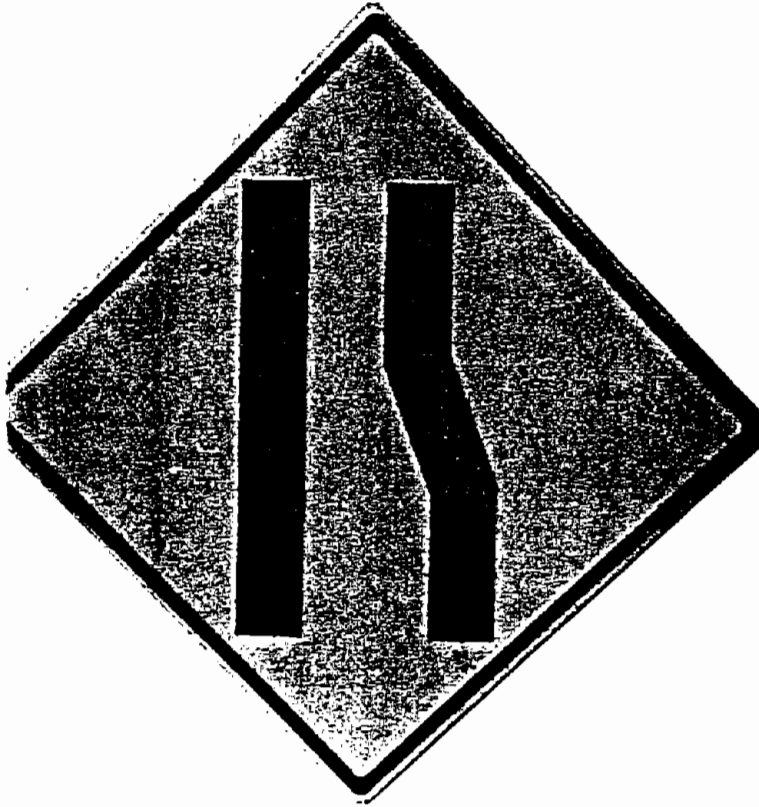
Action: _____

Meaning: _____



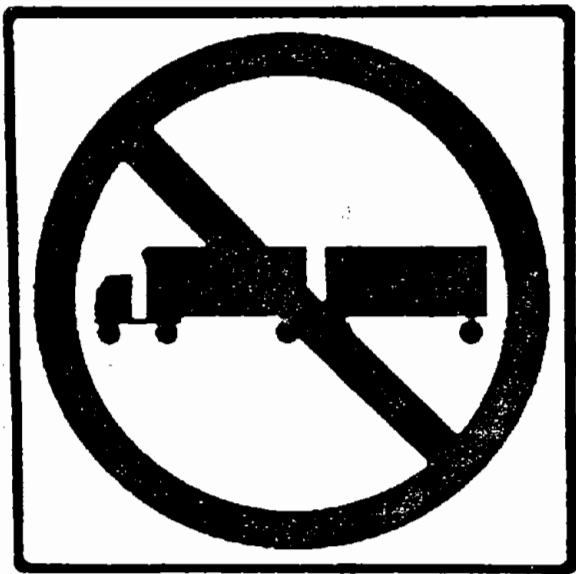
Action: _____

Meaning: _____



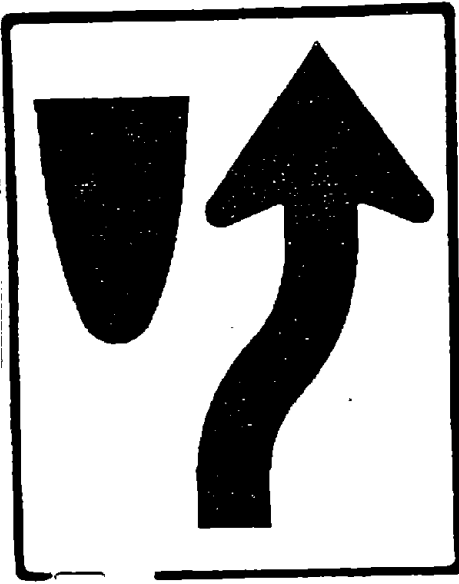
Action: _____

Meaning: _____



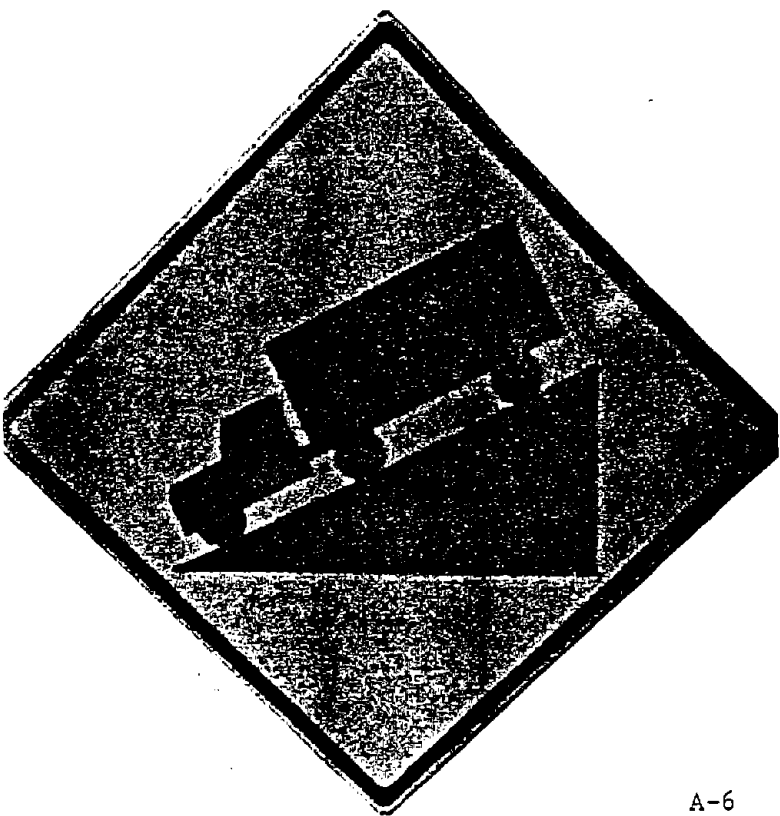
Action: _____

Meaning: _____



Action: _____

Meaning: _____

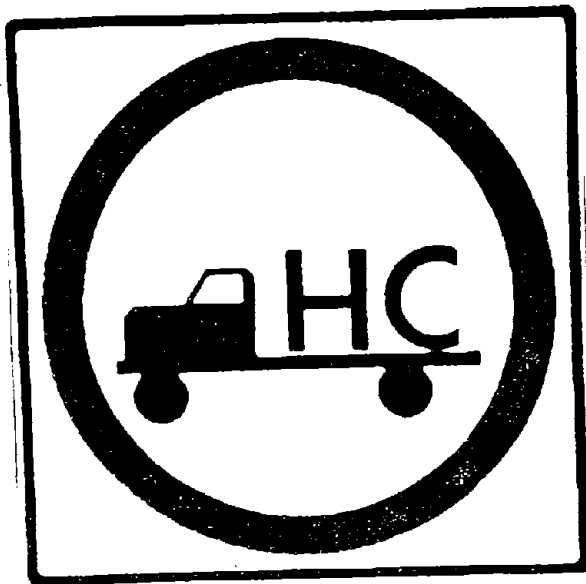


Action: _____



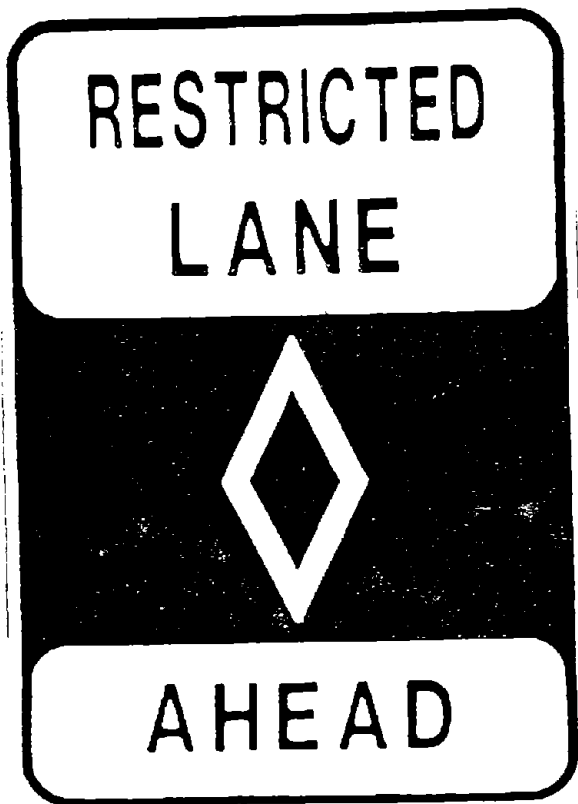
Meaning: _____

Action: _____



Meaning: _____

Action: _____



Meaning: _____

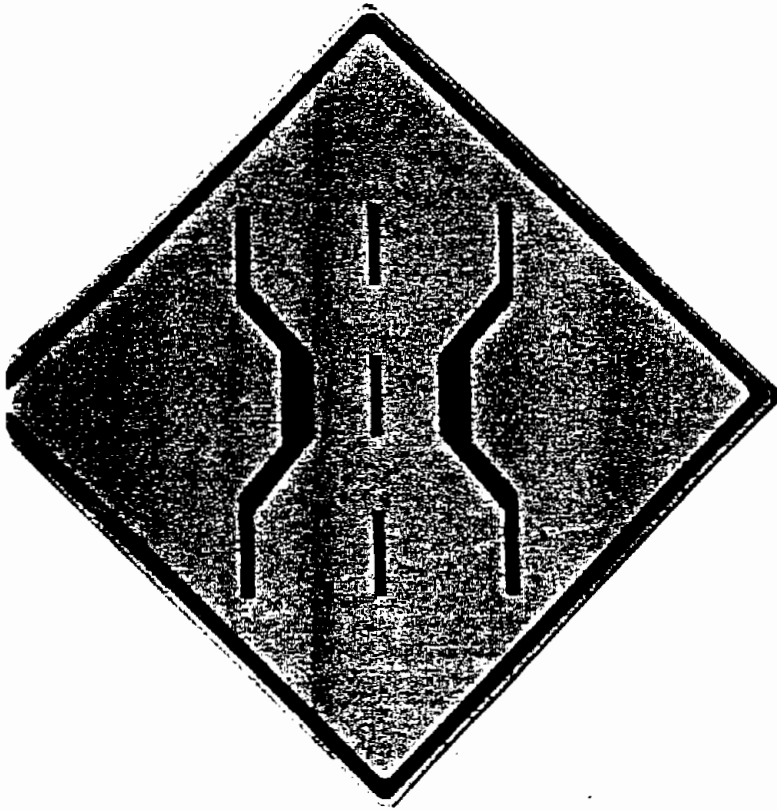
Action: _____



Meaning: _____

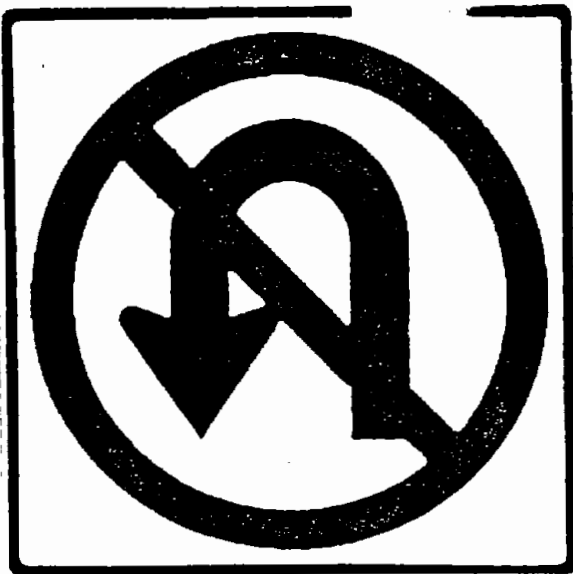
Action: _____

Meaning: _____



Action: _____

Meaning: _____



Action: _____

Meaning: _____



Action: _____

Meaning: _____

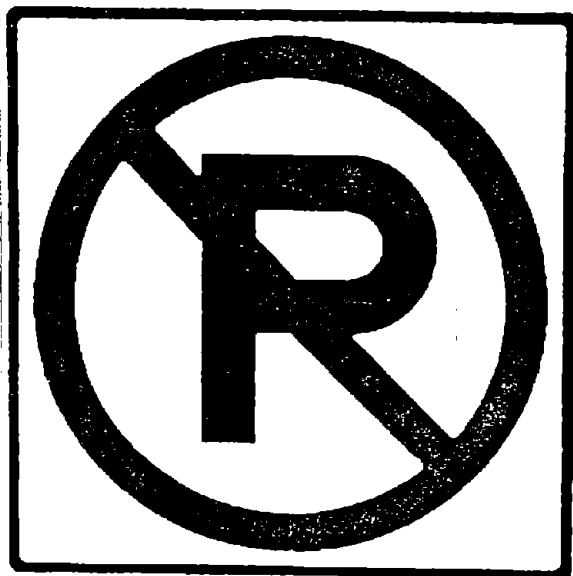


Action: _____



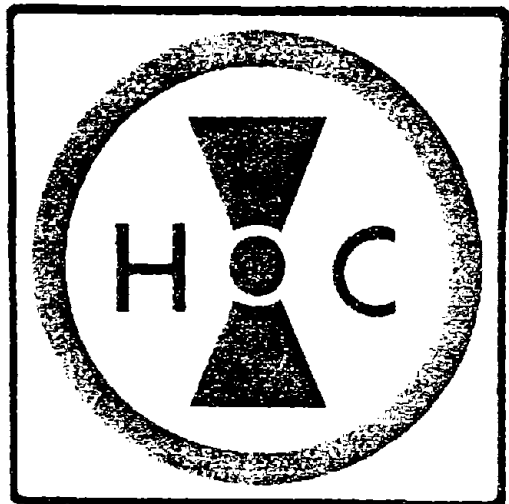
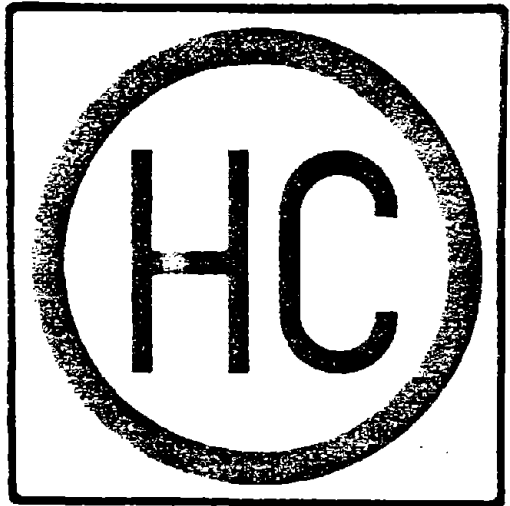
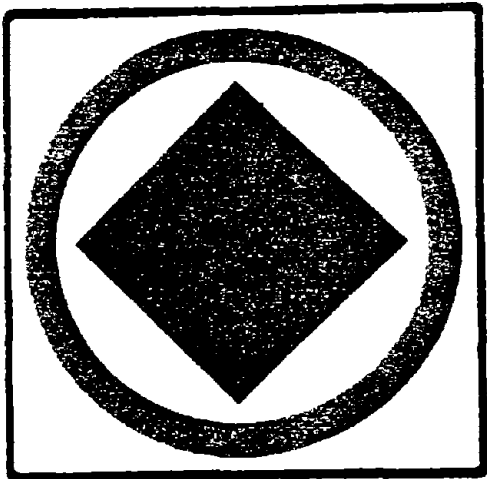
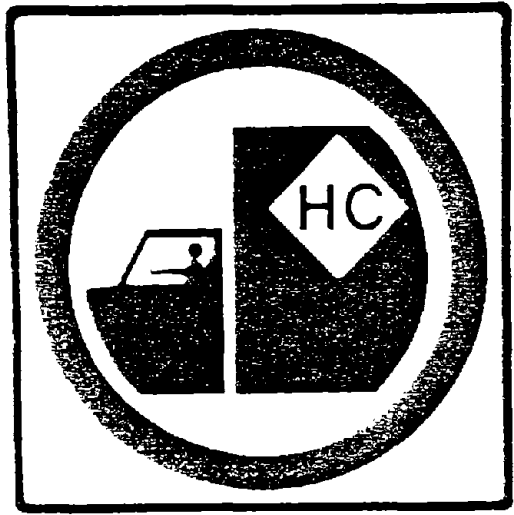
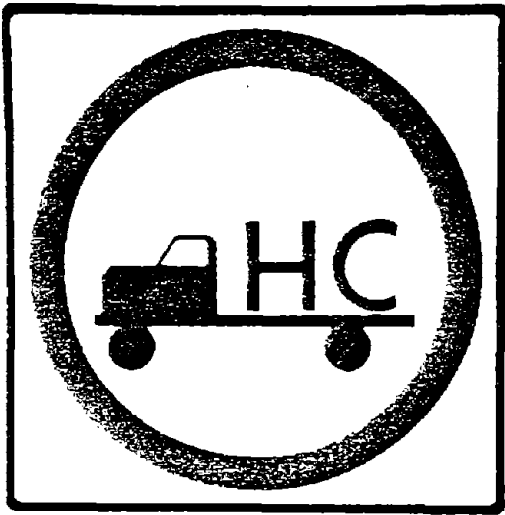
Meaning: _____

Action: _____



Meaning: _____

Action: _____



RECORD OF INFORMED CONSENT

Part 46, Subtitle A to Title 45 of the Code of Federal Regulations relating to the Protection of Human Subjects in research requires your informed consent for participation in Federal Highway Administration driving studies. Section 46.103(c) gives the following definition: "Informed consent means the knowing consent of an individual or his legal authorized representative, so situated as to be able to exercise free power of choice, without undue inducement or any element of force, fraud, deceit, duress, or other form of constraint."

Your participation as a subject in a study to evaluate highway symbol signs is requested. Please consider the following elements of information in reaching your decision whether or not to consent.

1. You will be asked for a minimum amount of biographical information necessary to the study. All information you provide is confidential and the source (your name) will not be disclosed to the public.
2. You will look at 18 highway signs in this booklet and record the name or meaning of each, and what affect each would have on your driving.
3. You will look at 6 signs and rank them according to how well they convey the meaning they are supposed to.
4. You are free to decline consent, or withdraw consent and discontinue participation in the session at any time.
5. Upon completion of the booklet, you will be paid \$5.00 for you participation.

The basic elements of information have been presented and understood by me, and I consent to participate as a subject.

NAME (please print): _____

SIGNATURE: _____

DATE: _____

Data sheet for tunnel study, Hazardous Cargo Route Sign.

Part I. Legibility Distances

Order 2	Sign	Shape of Sign	Color of Background	Ring (not Circle)	Slash	Color of Ring/Slash	Letter(s), Unspecified	Letter H	Letter C	Shape, Unspecified	Black Circle (A only) Sq/Rect (others)	Truck	Diamond 3	Hourglass 4	Small Dot in center
—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	C	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	F	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes:

1. Codes for missing data:

N means not applicable, such as slash with green slides.

S means skipped. We can assume the subject saw the feature but did not mention it. Shape or color of sign omissions, when subject has identified them previously, are examples. Also 'shape, unspecified' would be coded as S when subject only gives a specific shape.

O means omitted. We cannot assume the subject perceived the feature. Examples would be 'diamond' not mentioned on sign F or the shape on sign D not interpreted as a rectangle.

U means unknown reason for missing data, i.e., a wastebasket category.

D means 'don't know', which only applies to Part II.

2. 1=A, 2=B, 3=C, 4=D, 5=E, 6=F.

3. Also accept "a square on an angle", or motions implying such.

4. Also accept "radioactive symbol" or "two triangles".

Part II is on the other side.

Part III. Preference

A	B	C	D	E	F
—	—	—	—	—	—

Data Sheet For Tunnel Study, Hazardous Cargo Route Sign.

Part II. Recognition.

<u>Sign</u>	<u>Confusion 1</u>	<u>Dist.</u>	<u>Confusion 2</u>	<u>Dist</u>	<u>Presentation</u>	<u>Distance /Code as</u>
					<u>Order</u>	<u>at which / D if</u>
						<u>Correctly / Don't</u>
						<u>Identified/ Know</u>
1(A) Black Circle/HC	_____	_____	_____	_____	_____	_____
2(B) White Circle/HC	_____	_____	_____	_____	_____	_____
3(C) Truck, Flat/HC	_____	_____	_____	_____	_____	_____
4(D) "Bow Tie"/HC	_____	_____	_____	_____	_____	_____
5(E) Diamond	_____	_____	_____	_____	_____	_____
6(F) Truck, Close-up	_____	_____	_____	_____	_____	_____
7. No Left Turn	_____	_____	_____	_____	_____	_____
8. No U Turn	_____	_____	_____	_____	_____	_____
9. HOV Ahead	_____	_____	_____	_____	_____	_____
10. No Trucks	_____	_____	_____	_____	_____	_____
11. No Parking	_____	_____	_____	_____	_____	_____
12. Do Not Enter	_____	_____	_____	_____	_____	_____
13. (No) Big Trucks	_____	_____	_____	_____	_____	_____
14. Keep Right	_____	_____	_____	_____	_____	_____
15. Road Narrows	_____	_____	_____	_____	_____	_____
16. Hill	_____	_____	_____	_____	_____	_____
17. Narrow Bridge	_____	_____	_____	_____	_____	_____
18. Winding Road	_____	_____	_____	_____	_____	_____

Notes:

1. If there were no confusions, be sure to leave a blank line in the data file.
2. Codes for missing data:
 BLANKS for no confusions.
 D means "don't know" under distance column.
 U means unknown reason for missing data.