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California Steam Bus Project

surveys

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CALIFORNIA STEAM BUS PROJECT

FINAL REPORT -- SURVEYS

1. Patron Attitudes
2. Transit Managers
3. Driver Attitudes

This Report is the product of a project financed in part by the U.S. Department of Transportation, Urban Mass Transportation Administration.

The contents of this Report reflect the views of Scientific Analysis Corporation, which was responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policy of the Department of Transportation. This Report does not constitute a standard, specification or regulation.

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16. Abstract Under the California Steam Bus demonstration project, Rankine Cycle external combustion propulsion systems were installed on three conventional motor coaches, replacing the original diesel engines. This report presents survey data collected among bus passengers, transit managers, and bus drivers concerning attitudes toward the steam-powered vehicles. For comparative purposes, passengers were surveyed on both conventional diesel and modified steam buses. Characteristics of the survey samples and methodology are described. The findings revealed a high public concern for the problems of air pollution and an overwhelmingly favorable response to the steam buses. All relevant data and major crosstabulations are presented. The survey of transit managers focused on the role of steam bus technology as an attractive anti-pollution measure. Respondants emphasized economic factors and the need for continued research and development. Lastly, in-depth personal interviews were conducted with each of five operators of both diesel and steam buses. Comfort, operating, and general attitude factors were stressed. Findings are presented with reference to quietness, smoothness, power, odor, smoke, safety, pollution, handling, operation, and passengers' reactions. All five drivers expressed a preference for the steam bus.					
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To evaluate public reaction to the innovative concept of steam powered public transportation vehicles, 546 bus riders were interviewed by a Scientific Analysis Corporation field team that went riding on standard city routes. During test runs under actual transit conditions, 239 passengers of the three experimental steam buses were asked about their reactions to the bus itself as well as their opinions on public issues in the environmental realm. A similar interview was conducted with 307 passengers of conventional diesel vehicles traveling the same routes at the same times. The results of these field surveys consistently show strong public acceptance of steam as an energy source. Detailed distribution statistics appear at the end of this section.

Due to the carefully controlled selection procedure, the two groups -- steam and diesel riders -- were virtually identical in sociodemographic characteristics, an important point that helps insure reliability between the two populations. Slightly over half of the total sample were women. There was a good age distribution with roughly half of the respondents under forty. Almost three-fourths were white, with a relatively large number (17.0%) of blacks. A broad range of professions were represented, from the unemployed to upper administrative personnel.

Some 41.8% of the interviews were collected during early morning commute runs, 25.1% during late morning and the remaining 33.2% in the early afternoon prior to rush hour. This allowed us to include regular daily riders as well as more casual users. About three-fourths of the subjects were daily riders -- experienced riders whose opinions on transit matters would be crucial to mass-acceptance of technical innovations.

To determine general attitudes about pollution and environmental issues, we began by asking the respondents how deeply they were concerned about air pollution. As would be expected, virtually all subjects expressed concern about this much publicized problem. In the total sample, 58.6% said they were "deeply concerned"

about air pollution, with an additional 29.9% professing to be "somewhat concerned." the 9.9% that said they were "not very concerned" included a small number of persons who seemed resistant to the interview situation generally, and perhaps expected the interviewer to vanish when lack of concern was expressed. Conservatively, then, roughly 90% of the bus riders have definite awareness of air pollution as a cause for public concern.

When asked to list what they felt were the most significant sources of air pollution, a variety of opinions emerged. The most frequently mentioned source (72.7%) was automobile exhaust emissions -- not a surprising finding in urban settings. Second place went to "industry" in general (59.9%). Bus exhaust emissions and aircraft followed in third and fourth places respectively (35.5% and 30.2%). At the bottom half of the list of concerns were fireplaces (5.3%), backyard burning (9.0%), oil refineries (23.8%) and diesels (29.9%). Generally speaking, this gives a picture of mass pollution on a grand scale -- millions of autos coupled with "big business" that most riders felt little or no identification with. It is a depersonalized view of an overwhelming problem that the man in the street (or man on the bus) can do little or nothing about.

When asked to list the measures they felt would be most effective in controlling the air pollution problem, the most frequently mentioned step (47.6%) was to control automobile exhaust emissions, in line with the earlier concern about this source of air pollution. Next came control of chemical wastes (41.2%), use of public transportation and mass transit systems (37.2%), use of smoke control devices (36.3%) and complete abolition of the internal combustion automobile engine (28.9%). With the exception of use of public transit resources, all these approaches involve technical innovations that would require substantial changes in many industrial and public practices. The continued concern over the internal combustion engine reveals a strong undercurrent of public feeling that could give steam vehicles a hefty push

if their advantages could be made clear to the general bus patron. Less frequently mentioned control options included moving industry to the suburbs (13.0%), formation of car pools (17.0%), education of the public (20.0%), control of rubbish burning (20.0%), careful study and research (20.9%) and strong enforcement of anti-pollution legislation (26.4%).

Against this backdrop of concern, how did riders of the steam bus like their experimental vehicle? Acceptance was quite high. Sixty-four-and-nine-tenths percent said they noticed some difference in performance, mainly identified as a smoother ride. Some patrons were uncertain whether this was due to improved performance or some difference in the way the driver handled his run -- from the engineer point of view, the slightly slower speed was the main contributing factor.

The modern, clearly designed interior of the bus drew many compliments. Forty-three-and-five-tenths percent mentioned the carpeting as a desirable factor and 26.4% praised the new vehicles' cleanliness. In fact, the unusually attractive seats were a source of some concern among some riders who despaired at the threat of vandalism. An additional 41.8% of the steam bus patrons made further approving remarks of various kinds. A common theme was the increased roominess and special seating arrangement. In sum, 77.4% of the steam riders found the bus more attractive than regular diesel models.

Most riders felt that the bus had a smoother ride, produced less smoke and would generate less smog than a diesel bus. There was some uncertainty as to the power level of the steam engine; 40.6% thought the bus had less power, despite engineering information to the contrary. The noise level was pretty much undecided, with a slight tendency to rate the steam bus as quieter than diesel. Almost half the patrons found the steam bus to have less odor. There was little concern over safety problems; 68.6% rated it as safe as a diesel bus and only 2.5% considered it less safe.

On the crucial issue of the contribution steam powered public transportation vehicles would make to helping the air pollution problem, 38.5% of the total sample felt the steam bus would help "a great deal," with another 44.0% believing it would help "somewhat." Only 4.4% felt it would have no impact, and 13.2% had no opinion.

Public awareness of the effort to develop a steam vehicle has increased in recent months, bringing the number of respondents who had read about or heard of plans to operate a steam bus to 55.5%, a new high.

Of all respondents, an overwhelming 94.0% had no reservations about riding a bus powered by steam. Only 2.2% would not ride such a vehicle, and 3.8% had no opinion. We conclude that public acceptance of this innovative transportation concept is extremely strong. Steam has a good public image -- riders view it as clean, efficient and ecologically sound. We see no attitudinal barriers to mass use of such vehicles at this time.

We move now to a comparative analysis of public reaction to the three vendor vehicles. The Lear and Steam Power busses were prototypes with actual marketing potential, while the Brobeck effort was essentially a feasibility project that did not concern itself as extensively with its public interface. Due to technical problems, only nineteen interviews were conducted on the Steam Power bus, in contrast to the 112 and 108 for Lear and Brobeck respectively. All comparisons should take this difference in sample size into account.

There were sociographic differences between the three groups of steam riders, primarily due to the fact that not all runs were made at the same time of day. The Lear runs were made in the early morning on commute routes, Steam Power was surveyed in the late morning on a general purpose route and Brobeck samples were taken about fifty-fifty in the late morning and early afternoon. Lear riders were somewhat more fully employed, particularly in private entrepreneurial situations, a greater number of retired persons on Steam Power runs and a more mixed distribution, with

relatively many students, on the Brobeck bus. There were no significant differences in the sex of the riders. Lear riders had the broadest age distribution. Steam Power respondents tended to be older and Brobeck riders clustered somewhat in the twenties and over sixty categories. Lear riders were uniformly white; Brobeck had the largest proportion of non-whites and Steam Power fell somewhere between these extremes.

Lear riders were somewhat more worried about pollution issues, with only 1.8% indicating no real concern in that area, compared with 15.8% and 12.0% for Steam Power and Brobeck respectively. As would be expected from the time periods of the runs, 96.4% of the Lear riders were daily bus users, making twenty or more trips a month. This figure compares with 68.4% of Steam Power riders and 50.9% of the Brobeck patrons.

Given the fact that the Brobeck vehicle was designed more as a technical exercise than a marketing trial, it is not surprising that it had the smallest percentage of riders considering it to be more attractive than a regular bus (66.7% as opposed to 83.9% for Lear and a striking 100% for Steam Power). Brobeck's use of music was mentioned as an attractive feature by only 17.6% of the riders. When asked specifically to describe their reaction to the music, only 53.7% of all riders said they liked it, with the remaining patrons split about fifty-fifty between dislike and no opinion. Carpeting was much more frequently volunteered as a positive design component (32.1% for Lear, 48.1% for Brobeck, 84.2% for Steam Power). When asked specifically about whether they liked having carpeting in buses, 85.7% of Lear riders, 85.2% for Brobeck and fully 100% for Steam Power said yes. Brobeck's chrome fare box drew compliments from 6.5% of the patrons. All three busses drew about the same reaction to the cleanliness of their interiors, with 20.5%, 26.3% and 32.4% commenting on the Lear, Steam Power and Brobeck vehicles respectively. The absence of advertisements was mentioned fairly infrequently -- only 7.1% for Lear, 5.6% for Brobeck and not at all for Steam Power. Assorted other positive volunteered

comments were made by 10.5% of the Steam Power riders, 19.4% for Brobeck and a large 68.8% of Lear patrons. One major theme in these remarks was the spaciousness of the seating arrangements and references to the use of separate seats for each person.

Patrons showed definite trends in their evaluations of performance. When asked whether the bus seemed to perform better than a regular bus, 51.9% of Brobeck patrons, 68.4% for Steam Power and 76.8% for Lear said yes. Since patrons were comparing their experimental vehicles to local conventional busses, these and all the following figures do not represent genuine comparison statistics between the three steam buses, since riders never actually rode all three of them. Opinions were divided on the noise question. For the Lear bus, 49.1% said it was quieter and 28.6% said it was noisier. Comparable figures were 42.1% and 5.3% for Steam Power, and 26.9% and 37.0% for Brobeck.

When asked if the ride seemed smoother than normal, "yes" responses were given by 73.2% of the Lear riders, 57.9% for Steam Power and 52.8% for Brobeck, with almost all other patrons saying there was no noticeable difference. As to the issue of the bus power, 10.7% of Lear riders felt it had more power than a regular bus and 64.3% felt it had less. For Brobeck the figures were 7.4% versus 22.2%, and Steam Power had 21.1% and 5.3%.

Forty-four-and-six-tenths percent of the Lear riders said the bus had less odor than a regular bus, while 57.9% and 46.3% of the Steam Power and Brobeck riders said the same about their vehicles. On the essential pollution question of whether the bus produced more or less smoke, 85.7%, 73.7% and 62.0% of the Lear, Steam Power and Brobeck riders felt it would generate less than a regular bus and 91.1%, 84.2% and 75.0%, respectively, felt it would produce less smog on the whole.

As for safety, all buses were perceived about the same, with about two-thirds of the patrons considering the buses about equivalent to conventional vehicles. There were little differences in the number of riders who had heard about the steam bus

concept -- about a third of the patrons were unaware of the project until actually on the bus itself. Approval of the steam bus concept and willingness to ride such a vehicle was about the same for all three buses.

In summary, despite sociodemographic differences, all riders tend to favor the idea of steam powered public transportation vehicles and demonstrate considerable concern over pollution questions in general.

A. Concern About Pollution

	deeply concerned	somewhat concerned	not very concerned	no opinion
Steam	66.5	25.5	7.5	0.4
Diesel	52.4	33.2	11.7	2.6
TOTAL	58.6	29.9	9.9	1.6

B. Pollution Sources

	Steam	Diesel	Total
Aircraft, jets, airports	32.2	28.7	30.2
Auto exhaust	74.5	71.3	72.7
Bus exhaust	41.0	31.3	35.5
Diesel trucks	31.0	29.0	29.9
Industry and factories	55.6	63.2	59.9
Oil refineries	23.4	24.1	23.8
Backyard burning	10.5	7.8	9.0
Fireplaces	4.6	5.9	5.3
Other	3.3	6.5	5.1

C. Most Effective Control Measures

	Steam	Diesel	Total
Find way to control auto exhaust, develop a new fuel	48.5	46.9	47.6
Do away with gasoline engine	33.1	25.7	28.9
Control chemical and industrial wastes	39.3	42.7	41.2
Move industry to suburbs or other places	39.3	42.7	41.2
Smoke control devices, filters	8.8	16.3	13.0
Control burning rubbish or garbage	37.7	35.2	36.3
Enforce law, pass new legislation	18.0	21.5	20.0
Careful study, research	23.8	28.3	26.4
Educate public	19.7	21.8	20.9
Use public transportation, rapid transit	16.7	22.5	20.0
Form car pools	35.6	38.4	37.2
Other	18.4	16.0	17.0
	8.8	6.8	7.7

SURVEY SAMPLE POPULATION CHARACTERISTICS

	<u>Steam</u>	<u>Diesel</u>	<u>TOTAL</u>
Male	46.4	40.4	43.0
Female	53.6	59.6	57.0
10 - 19 years	6.7	15.3	11.5
20 - 29	23.4	29.0	26.6
30 - 39	14.2	16.9	15.8
40 - 49	15.5	12.1	13.6
50 - 59	16.7	14.0	15.2
60+	23.4	12.7	17.4
Asian	4.2	5.5	4.9
Black	15.9	17.9	17.0
Caucasian	76.2	68.1	71.6
Latino	2.9	6.8	5.1
Other ethnicity	0.8	1.6	1.2
Unemployed	3.3	3.6	3.5
Executive, large concerns, major professionals	4.6	2.3	3.3
Managers, medium sized business, lower professionals	9.6	4.6	6.8
Administration, personnel large concerns, owners small independent business, semi-professionals	10.9	9.4	10.1
Owners little business, clerical, sales, technicians	27.6	27.4	27.5
Skilled workers, artisans, craftsmen	6.3	8.5	7.5
Semi-skilled workers	3.8	4.2	4.0
Unskilled workers	1.7	1.0	1.3
Housewives	7.1	8.1	7.7
Students	12.1	22.5	17.9
Retired	13.0	8.5	10.4

A. Performance Characteristics (Steam Riders Only)

	better	same	worse	No opinion
Quiet?	38.5	25.5	30.5	5.4
Smooth?	62.8	28.9	3.3	5.1
Power?	10.0	33.1	40.6	16.4
Odor?	46.4	33.5	11.3	8.7
Smoke?	74.1	8.8	1.7	15.5
Safe?	14.2	68.6	2.5	14.6
Smog?	83.3	6.7	0.8	9.2

B. Would Steam Help Reduce Air Pollution?

	great deal	somewhat	not much	no opinion
Steam	47.3	43.5	1.7	7.5
Diesel	31.6	44.3	6.5	17.6
Total	38.5	44.0	4.4	13.2

C. Heard about Steam?

	yes	no	no opinion
Steam	60.3	37.7	2.1
Diesel	51.8	46.9	1.3
Total	55.5	42.9	1.6

D. Would You Ride a Bus Powered by Steam?

	yes	no	no opinion
Steam	95.8	2.9	1.3
Diesel	92.5	1.6	5.9
Total	94.0	2.2	3.8

CROSSTABULATION OF VENDOR BY OCCUPATION

Figures are shown as percentages of riders on the given vehicle

Vendor:	Unemployed	Executive, large concerns, major professionals	Managers, medium sized business, lower professionals	Administration	Owners little business, clerical, sales, technicians	Skilled workers, artisans, craftsmen	Semi-skilled workers	Unskilled workers	Housewives	Student	Retired
Lear	0.0	7.1	17.9	19.6	49.1	1.8	0.9	0.0	0.9	1.8	0.9
Steam Power	0.0	0.0	5.3	0.0	10.5	10.5	5.3	0.0	10.5	10.5	47.4
Brobeck	7.4	2.8	1.9	3.7	8.3	10.2	6.5	3.7	13.0	23.1	19.4

$\chi^2 = 160.391$ with 20 d.f.

$p < .001$

TRIPS PER MONTH

	20+	10 - 19	3 - 9	under 3
Steam	73.6	7.9	8.8	9.6
Diesel	73.0	9.4	6.5	11.1
TOTAL	73.3	8.8	7.5	10.4

CROSTABULATION OF VENDOR BY RACE

figures are shown as %s of riders

Vendor:	White	Black	Oriental	Latino	Indian
Lear	92.0	1.8	5.4	0.9	0.0
Steam Power	73.7	15.8	0.0	10.5	0.0
Brobeck	60.2	30.6	3.7	3.7	1.9

$\chi^2 = 45.130$ with 8 d.f.

$p < .001$

CROSSTABULATION OF VENDOR BY SEX

Vendor:	%s of riders	
	Male	Woman
Lear	39.3	60.7
Steam Power	52.6	47.4
Brobeck	52.8	47.2

$\chi^2 = 4.341$ with 2 d.f.

p = n.s.

CROSSTABULATION OF VENDOR BY AGE

figures are shown as %s of riders on the given vehicle

Vendor:	10-19	20-29	30-39	40-41	50-51	60+
Lear	2.7	21.4	17.9	20.5	26.8	10.7
Steam Power	0.0	15.8	15.8	5.3	5.3	57.9
Brobeck	12.0	26.9	10.2	12.0	8.3	30.6

$\chi^2 = 48.556$ with 10 d.f.

p < .001

CROSSTABULATION OF VENDOR BY RELATIVE ATTRACTIVENESS

figures are shown as %s

Vendor:	Yes	No	No Opinion
Lear	83.9	7.1	9.0
Steam Power	100.0	0.0	0.0
Brobeck	66.7	9.3	24.1

$\chi^2 = 24.261$ with 6 d.f.

$p < .001$

CROSSTABULATION OF VENDOR BY "PERFORMS BETTER"

figures are shown as %s of riders

Vendor:	Yes	No
Lear	76.8	23.2
Steam Power	68.4	31.6
Brobeck	51.9	48.2

$\chi^2 = 16.974$ with 4 d.f.

$p < .01$

CROSSTABULATION OF VENDOR (LESS ODOR)

figures are shown as %s of riders

Vendor:	Less odor	Same	More odor	No opinion
Lear	44.6	28.6	18.8	8.0
Steam Power	57.9	36.8	0.0	5.3
Brobeck	46.3	38.0	5.6	10.2

$\chi^2 = 13.60934$ with 8 d.f.

$p < .10$

CROSSTABULATION OF VENDOR (LESS SMOKE)

figures are shown as %s of riders

Vendor: Less smoke Same More smoke No opinion

Lear	85.7	0.9	0.9	12.5
Steam Power	73.7	5.3	0.0	21.1
Brobeck	62.0	17.6	2.8	17.6

$\chi^2 = 24.75250$ with 6 d.f.

$p < .001$

CROSSTABULATION OF VENDOR BY "MORE POWER"

figures are shown as percentages of riders

Vendor:	More Power	Same	Less Power	No Opinion
Lear	10.7	8.9	64.3	16.1
Steam Power	21.1	63.2	5.3	10.5
Brobeck	7.4	52.8	22.2	17.6

$\chi^2 = 72.118$ with 8 d.f.

$p < .001$

CROSSTABULATION OF VENDOR BY "LESS SMOG"

figures are shown as percentages of riders

Vendor:	Less Smog	Same	More Smog	No Opinion
Lear	91.1	1.8	0.9	6.3
Steam Power	84.2	5.3	0.0	10.5
Brobeck	75.0	12.0	0.9	12.0

$\chi^2 = 14.572$ with 8 d.f.

$p < .10$

CROSSTABULATION OF VENDOR BY "IS QUIETER"

Vendor:	figures are shown as percentages of riders			
	Quieter	Same	Noisier	No Opinion
Lear	49.1	17.0	28.6	5.4
Steam Power	42.1	42.1	5.3	10.5
Brobeck	26.9	31.5	37.0	4.6

$\chi^2 = 21.333$ with 8 d.f.

$p < .01$

CROSSTABULATION OF VENDOR BY "SMOOTHER RIDE"

Vendor:	figures are shown as percentages of riders			
	Smoother	Same	Rougher	No Opinion
Lear	73.2	19.6	3.6	3.6
Steam Power	57.9	36.8	0.0	5.3
Brobeck	52.8	37.0	3.7	6.5

$\chi^2 = 13.427$ with 8 d.f.

$p < .10$

CROSSTABULATION OF VENDOR BY "STEAM WOULD BE GOOD DEAL"

figures are shown as %s of riders

Vendor:	Great Deal	Some	Not Much	No Opinion
Lear	48.2	42.9	0.9	8.0
Steam Power	63.2	26.3	0.0	10.5
Brobeck	43.5	47.2	2.8	6.5

$\chi^2 = 4.935$ with 6 d.f.

p=n.s.

CROSSTABULATION OF VENDOR BY "WOULD RIDE A STEAM BUS"

percentages of riders

Vendor:	Yes	No	No Opinion
Lear	96.4	3.6	0.0
Steam Power	94.7	0.0	5.3
Brobeck	95.4	2.8	1.9

$\chi^2 = 4.875$ with 4 d.f.

p=n.s.

CROSSTABULATION OF VENDOR (SAFER)

figures are shown as %s of riders

Vendor:	Safer	Same	Less safe	No opinion
Lear	9.8	69.6	3.6	17.0
Steam Power	21.1	68.4	0.0	10.5
Brobeck	17.6	67.6	1.9	12.9

= 6.55968 with 8 d.f.

p = n.s.

CROSSTABULATION OF VENDOR (HEARD ABOUT STEAM BUS)

figures are shown as %s of riders

Vendor	Yes	No	No opinion
Lear	61.6	38.4	0.0
Steam Power	63.2	31.6	5.3
Brobeck	58.3	38.0	3.7

$\chi^2 = 4.2921$ with 4 d.f.

p = n.s.

STEAM BUS PATRON ATTITUDE SURVEY

Scientific Analysis Corporation
4339 California Street
San Francisco, California 94118

Interviewer: _____

Time/Date: _____

(1) Steam Bus

(2-5) _____ Subject #

(6-7) Route #

Hello, I'm working for Scientific Analysis Corporation on a study of new developments in bus transportation. And we are asking passengers for their opinion. May I ask you a few questions?

1. You may have heard or read claims that air pollution or smog has reached a point where it is dangerous to human health. How concerned are you about this -- deeply concerned, somewhat concerned, or not very concerned?

- (8) 1. Deeply concerned
 2. Somewhat concerned
 3. Not very concerned
 0. Don't know, no opinion

2. What do you personally think are the main causes of smog or air pollution?

- (9) 1. Aircraft, jets, airports
(10) 2. Auto exhaust
(11) 3. Bus exhaust
(12) 4. Diesel trucks
(13) 5. Industry and factories
(14) 6. Oil refineries
(15) 7. Backyard burning
(16) 8. Fireplaces
(17) 9. Other: _____

3. In your opinion, what can be done to reduce air pollution or smog?

- (18) 1. Find way to control auto exhaust, develop a new fuel
- (19) 2. Do ~~any~~ with gasoline engine
- (20) 3. Control chemical and industrial wastes
- (21) 4. Move industry to suburbs or other places
- (22) 5. Smoke control devices, filters
- (23) 6. Control burning rubbish or garbage
- (24) 7. Enforce law, pass new legislation
- (25) 8. Careful study, research
- (26) 9. Educate public
- (27) 10. Use public transportation, rapid transit
- (28) 11. Form car pools
- (29) 12. Other (write in): _____

4. In your opinion which causes more air pollution, a car or a bus?

- (30) 1. Car
- 2. Bus
- 3. Don't know, no opinion

5. How often do you ride the bus?

- (31) 1. Daily, (20 trips per month or more)
SKIP TO QUESTION #7
- 2. Frequently (10 to 19 trips per month)
- 3. Occasionally (3 to 10 times per month)
- 4. Rarely or never (less than 3 times a month)

IF FREQUENTLY, OCCASIONALLY, RARELY OR NEVER:

6. Why don't you use the bus more often?

- (32) 1. Use own automobile
- (33) 2. Use friend/relative's automobile
- (34) 3. Bus not close to home
- (35) 4. Bus not routed for travel needs
- (36) 5. Bus too expensive
- (37) 6. Bus too slow
- (38) 7. Waiting for bus takes too long/service infrequent
- (39) 8. Bus too noisy
- (40) 9. Bus has unpleasant odor
- (41) 10. Bus too crowded
- (42) 11. General or vague dislike of bus
- (43) 12. Generally "no need for bus"
- (44) 13. Other (write in): _____

7. Does this bus make bus riding more attractive than other buses you have ridden?

- (45) 1. Yes
- 2. No SKIP TO QUESTION #9
- 3. Don't know, no opinion

8. How do you find this bus more attractive?

- (46) 1. Music
- (47) 2. Carpeting
- (48) 3. Chrome fare box
- (49) 4. Clean, looks new
- (50) 5. No advertisements on the walls--looks good
- (51) 6. Other (write in): _____

9. As you may have noticed, the floor in this bus is carpeted. Do you like having carpeting in buses?

- (52) 1. Yes
- 2. No
- 3. Don't know, no opinion

10. This bus also has recorded music piped in. Do you think this is a good feature?

- (53) 1. Yes -- SKIP TO QUESTION #11
- 2. No -- GO TO QUESTION #10A
- 3. Don't know, no opinion -- SKIP TO QUESTION #11

10A. Why is that?

- (54) 1. Too loud
- (55) 2. Don't like the type of music
- (56) 3. Don't like music on buses or in public places or conveyances
- (57) 4. Other (write in): _____

11. Does this bus seem to perform any differently from the buses you usually ride?

- (58) 1. Yes
 2. No

12. How would you compare the performance of this bus to that of a regular bus in the following ways:

A. Would you say this bus is quieter or noisier?

- (59) 1. Quieter
 2. About the same
 3. Noisier
 4. Don't know, no opinion

B. Is this a smoother ride or a rougher ride?

- (60) 1. Smoother ride
 2. About the same
 3. Rougher ride
 4. Don't know, no opinion

C. Does it seem to you that this bus has more power or less power?

- (61) 1. More power
 2. About the same
 3. Less power
 4. Don't know, no opinion

D. Do you notice less odor or more odor?

- (62) 1. Less odor
 2. About the same
 3. More odor
 4. Don't know, no opinion

E. Do you think this bus produces less smoke or more smoke?

- (63) 1. Less smoke
 2. About the same
 3. More smoke
 4. Don't know, no opinion

F. Do you feel this bus is safer or not as safe?

- (64) 1. Safer
 2. About the same
 3. Not as safe
 4. Don't know, no opinion

G. Do you think this bus will cause less pollution or more pollution?

- (65) 1. Less pollution
 2. About the same
 3. More pollution
 4. Don't know, no opinion

13. Have you heard about plans to use a bus powered by a steam engine in this city?

- (66) 1. Yes
 2. No
 3. Don't know

14. Do you think using steam buses would help reduce air pollution in this city a great deal, some, or not much?

- (67) 1. A great deal
 2. Some
 3. Not much
 4. Don't know

15. Would you ride a bus powered by steam?

- (68) 1. Yes SKIP TO QUESTION #17
 2. No
 3. Don't know

16. Why would you be unwilling to ride a steam bus?

- (69) 1. Afraid to ride a steam bus
(70) 2. Too unsafe; it could blow up and cause serious personal injury
(71) 3. Steam bus not dependable; it might breakdown
(72) 4. Steam bus is not progressive; it's returning to the ways of the past
(73) 5. Other: _____

17. What is your occupation, please? _____

And in what industry is that? _____

- (74)
- 1. Executive, large concerns, major professionals
 - 2. Managers, medium sized business, lower professionals
 - 3. Administration, personnel large concerns, owners small independent business, semi-professionals
 - 4. Owners little business, clerical, sales, technicians
 - 5. Skilled workers, artisans, craftsmen
 - 6. Semi-skilled workers
 - 7. Unskilled workers
 - 8. Housewives
 - 9. Student
 - 4. Retired
 - 0. Unemployed

18. Position on bus:

- (75)
- 1. Front
 - 2. Middle
 - 3. Back

19. Sex

- (76)
- 1. Male
 - 2. Female

20. Age (Estimate)

(77-78)

21. Race

- (79) 1. White
 2. Black
 3. Oriental
 4. Mexican-American
 5. American-Indian
 6. Other

22. Time Period

- (80) 1. Commuter--early morning
 2. Late morning
 3. Early afternoon

ATTITUDES OF TRANSIT MANAGER

TOWARD ALTERNATIVE POWER SYSTEMS TO COMBAT AIR POLLUTION

Innovations in bus transportation must be acceptable not only to the public, but to the transit industry as well. In the United States, both private industry and public service join efforts in the public transportation system. Most urban mass transit systems involve a working partnership of both groups. Therefore, in our survey of attitudes regarding the use of steam power as a viable alternative to the internal combustion engine, we contacted transit managers of all major bus transit districts in this country. We asked transit managers several questions about their concerns with air pollution, strategies for controlling or reducing air pollution and its relationship to bus usage and the costs of innovation in the bus industry. How much would they be willing to pay for a new way of combating air pollution? What should be the role of the government in controlling air pollution? These and similar questions form the basis of this study.

During the spring and summer of 1972 the survey staff of Scientific Analysis Corporation mailed questionnaires to all Transit Systems Members of the General Signal Corporation to all districts who had a fleet of more than 100 buses in operation. These include privately and publicly owned bus systems in the United States. Returns for this mailing procedure reflect the attitudes of transit managers of 75% of the buses now in operation. Forty-eight of the 65 questionnaires were

returned. Twenty-six public transit districts and twenty-two private districts are represented and these include the larger districts as well as several small firms. This is an exceptionally good return rate and allows us to treat this data as being both representative and reliable.*

Forty-five transit managers stated that they were concerned about air pollution and that they considered it to be a serious problem. In fact, over 80% (39) of the managers felt that air pollution had reached such a high level that they considered it to be dangerous to human life. Given this degree of awareness and concern, what do the transit managers feel is the role of buses in creating smog?

We asked these transit managers what they considered to be the main causes of air pollution, and to rank these causes according to their seriousness. The main cause for smog, of course, was the automobile. Three-fourths of the respondents ranked automobile exhaust as the primary cause of air pollution, while industries and factories were ranked second by two-thirds of the group. Third was the oil refineries. So, while the transit managers in general recognized that other activities are the major causes of air pollution, over one-half acknowledged exhaust fumes from buses also contributed to the poisoning of the atmosphere. Interestingly, as is reflected on the chart on the following page, the transit managers rank bus exhaust as the last preference of causes to air pollution.

* According to most survey methodologists, a return rate of 40% to 60% for mailed questionnaires is the usual expected return. Our return rate undoubtedly reflects a high degree of active awareness and interest among transit managers of the air pollution problem.

TRANSIT MANAGERS: MAIN CAUSES OF AIR POLLUTION OR SMOG

Ranked In Order of Seriousness*	1	2	3	4	5	6	7	8
Auto exhaust	40	3	2	1	2			
Industries and factories	5	25	3	2	1	3		
Oil refineries	3	12	6	3	3	1	1	
Aircraft, jets, airports		3	6	10	5	3	2	1
Truck exhaust		6	5	7	10	4	1	2
Bus exhaust			3	4	9	11	2	1

* A few of the questionnaires did not rank all eight items, only the first three, hence no totals.

Given this concern, what would they feel a proper solution to be?

We asked these respondents about what they thought could be done to reduce air pollution. One-third of the transit managers responded that the best solution to this problem would be the development of rapid transit systems and the wider use of public transportation (16). Another third felt that the first need to control air pollution would be to find a way to control auto exhaust and to develop new fuels (14). Others suggested a broad approach to the problem, including other public controls and careful study and research as well as find a clean alternate propulsion system.

As shown on the following table, nearly all mentioned the need to increase the use of public transportation as one of the ways to control air pollution. Although they indicated that automobiles are the number one cause of air pollution, these managers seem fully aware of the important role of public transportation while buses are a less crucial source, ranking behind industry, oil refiners, aircraft and truck exhaust.

TRANSIT MANAGERS: PRIORITY OF SOLUTION TO AIR POLLUTION

<u>Ranked in Order of Priority*</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>
Use Public transportation, rapid transit	16	19	5	4	1	1		
Control auto exhaust, develop new fuels	14	15	7	3	1			
Control chemical and industrial waste	7	8	8	5	3	2	2	
Careful study and research	6	2	3	3	4	5	3	3
Find clean alternate propulsion system	4	7	7	3	2	2	4	10
Enforce law, pass new legislation	1	3	3	4	5	3	3	3

* A few listed only three priorities

What would transit managers recommend to implement these opinions? We asked if they would favor spending gasoline tax money for research on air pollution. This question is an important one in the fact of the continuing controversy about diversion of these funds from highway construction. Nearly 94% (45) of the transit managers favor spending some gasoline tax money for research on air pollution or smog. This opinion seems fully consistent with their attitude about the seriousness of the problems of air pollution..

Since one-third of the transit managers had stated that one of the best ways to combat air pollution would be to increase the use of bus transportation, we asked the respondents what they believed would increase bus usage by the public. The responses to this question indicated that about one-half felt bus usage would be increased by having more buses with better (more frequent) service, while another 28% felt that lower or free fares would

greatly increase bus indulgence. In other words, transit managers still feel, in spite of public concern about automobile smog, the rules of the free market still operate. People will ride buses because they are efficient and free, not because buses might be made to run smog-free. This is an important factor in the whole problem of how to get people to make decisions for the good of all--rather than on the basis of personal convenience and cost.

We then questioned the transit managers if they felt there was a real need for the transit industry to find and adopt a clean propulsion system. Two thirds (32) responded yes, while one-third did not indicate there was such a need. We then asked if steam buses were quieter and cleaner than diesel buses, would their organizations consider purchasing them? This is a crucial question. Would the development of the steam bus meet with acceptance by the transit organizations? Over one-half (26) of the transit managers indicated their organizations would consider such purchases, while 13% (6) responded no and 33% (16) had no opinion at this time.

We asked the transit managers if they felt the use of steam buses would help reduce air pollution and found that over one-half (26) did not think steam bus usage would help much in reducing air pollution in their district, although 27% (13) felt the steam bus would have some effect. Only 2% (1) felt the wider use of steam buses would have a strong impact on air pollution. This finding is consistent with the transit managers attitude that they do not believe that the buses are very important as a cause of air pollution.

We then asked if they felt that steam buses would increase bus usage in their transit areas. Ten percent (5) said its use might increase bus usage

a little, while over half (25) did not feel it would have an impact and 33% (16) were undecided while 4% (2) indicated that it would not increase bus patrons at all.

Given these stated opinions, we were then confronted with a dilemma. That is, over one-half of the transit managers had stated their organizations might consider purchasing steam buses, although they also felt the steam bus would neither decrease air pollution nor increase bus usage significantly. Perhaps this is an indication of these respondents' awareness of the complexity of the air pollution problem and reflected their realization that there would be no simple solution to such a complicated phenomenon.

We then asked the transit managers a hypothetical question: If steam buses became commercially available, the purchase price might be more than that paid for diesel buses. How much of a premium would your transit district be willing to pay? The responses are as follows:

<u>TRANSIT MANAGERS:</u>	<u>WILLING TO PAY PREMIUM</u>
Ten percent more	10 (21%)
Twenty-five percent more	2 (4%)
No comment at this time	11 (23%)
Fifty percent more	- -
Not willing to pay any premium	16 (33%)
No response	9 (19%)
	<hr/> 48 (100%)

As can be seen, three-fourths of the transit managers are either ambivalent or unwilling to pay a higher premium for steam buses. Only one-fourth of the respondents indicated that their transit systems would pay additional costs for a steam bus. In short, they do not seem to view the

steam bus as the solution to air pollution problems if it would be more expensive. Once again, we see the philosophy of the market place still operating in spite of the transit managers' expressed concern about air pollution. This finding appears to reflect the seriousness of the entire problem of mobilizing the public in combatting air pollution. All agree that it is a problem. Few are willing to sacrifice convenience or financial gain in order to control it. This finding may indicate a need for government control or regulation in order to create a more viable environment.

We, therefore, asked the transit managers what role they thought the federal government should take in helping to fight air pollution. Only three-fourths (39) of the respondents answered the question, indicating a reluctance on the part of one-fourth of the transit managers to respond regarding this policy issue. Of those that did not respond to this question four were public owned, averaging about 580 buses, five privately owned averaging 180 buses.

Among those who responded, 56% (20) felt the federal government should provide operating subsidies to public transportation, to provide assistance for purchase of a clean propulsion system; 15% (5) felt the federal government should fund a massive research effort for a clean propulsion system; 15% (6) felt the government should encourage private industry to develop clean propulsion systems and the balance 14% (9) felt the government should increase the cost of private transportation to force the use of public transportation. In short, the transit managers saw the role of the federal government as a source of financial assistance, research effort and legal power.

In summary, the responses to the questionnaire indicate that transit managers are aware of and concerned about air pollution, but see their particular effort to combat air pollution to be less than central. In fact, they feel innovation and change from diesel to steam buses could be accomplished only if steam buses were competitive in price, or if there are adequate financial subsidies from the federal government. They indicate interest in a massive and continuous research effort in this field, showing their awareness of the complexity of the air pollution problem.

TRANSIT MANAGERS ATTITUDE SURVEY

1. As far as you personally are concerned, do you feel air pollution or smog is very serious, fairly serious or not a serious problem?
 1. Very serious
 2. Fairly serious
 3. Not serious
 4. No opinion

2. Do you think air pollution or smog has reached a point where it is a danger for normal, healthy people?
 1. Yes
 2. Maybe
 3. No
 4. No opinion

3. What do you, personally, think are the main causes of smog or air pollution? (Please rank in order of seriousness.)
 1. Aircraft, jets, airports
 2. Auto exhaust
 3. Backyard burning
 4. Truck exhausts
 5. Bus exhausts
 6. Industry and factories
 7. Oil refineries
 8. Other (please write answer)

4. In your opinion, what can be done to reduce air pollution or smog? (Please rank in order of priority.)
 1. Find way to control auto exhaust, develop new gasolines
 2. Do away with internal combustion engines
 3. Find a clean alternate propulsion system
 4. Control chemical and industrial wastes
 5. Enforce law, pass new legislation
 6. Careful study, research
 7. Control burning rubbish
 8. Use public transportation, rapid transit
 9. Other (please write answer)

5. Would you favor spending some gasoline tax money for smog or air pollution research?
 1. Yes
 2. No
 3. No opinion

6. In your opinion which of the following sources causes more air pollution? (Please rank in order of importance.)
 1. Cars
 2. Trucks
 3. Buses
 4. Industry
 5. No opinion

7. What do you believe will increase bus usage?
 1. More buses and more frequent service
 2. New, attractive buses
 3. Clean and quiet power systems
 4. Other mass transit vehicles
 5. Free fares
 6. Other (please write answer)

8. Do you feel there is a real need for the transit industry to find and adopt a clean propulsion system?
 1. Yes
 2. No
 3. No opinion

9. It is expected that steam buses would be quieter and cleaner than diesel buses. If they were available, would your organization consider purchasing steam buses?
 1. Yes
 2. No
 3. No opinion

10. If steam buses became commercially available, the purchase price might be more than paid for diesel buses. How much of a premium would your transit district be willing to pay?
 1. Ten percent more
 2. Twenty-five percent more
 3. Fifty percent more
 4. Not willing to pay any premium

11. Do you think a wider use of steam buses would help reduce air pollution in your district?
 1. A great deal
 2. Some
 3. Not much
 4. Don't know

12. Do you think that steam buses would increase bus usage in your transit area?
 1. A great deal
 2. Some
 3. Not much
 4. Don't know

DRIVER ATTITUDE SURVEY

An in-depth, personal interview was conducted by a trained interviewer with each of five operators of both diesel and steam buses. Two were instructors, while three were regular drivers. Four of the operators were from the Bay Area -- three employees of AC Transit and one employed by San Francisco Municipal Railway -- and the fifth from SCRTD in Los Angeles. These five men we interviewed all reported that they enjoyed being operators. They are experienced drivers -- having driven buses between nine and forty-three years.

The interviews consisted of a basic set of questions in which drivers compared the operation of the steam and diesel buses. The questions were all of the open-ended variety and were complemented with systematic probes by the interviewer.

The basic informational categories dealt with in the interview can be summarized as follows:

Comfort factors, e.g., smoothness of ride, noise level and degree of odor.

Operating factors, e.g., overall power, handling and safety of bus, and emissions.

General attitude factors, e.g., personal opinions from driver's point of view about driving the steam bus and their perception of passenger reactions.

The responses were recorded manually and on tape, and transcribed. Then the responses were categorized by item of information and by response. Finally, the data was content analyzed. A discussion of the findings follows.

The drivers were asked how the steam bus compared to diesel buses in terms of quietness. All the drivers mentioned that the steam bus was quieter. One of the drivers pointed out that "On the diesel you have a continuation of noise from the motor, but on the steam bus you can't hear anything." Two of the drivers mentioned that it was quieter both inside and out, while two others said the interior noise was the same or "sometimes noisier" than the diesel, but that the steam bus was quieter outside.

They were also questioned on comparative smoothness of the ride. Here again, all the drivers stated that the steam bus was "definitely smoother". Three of the five drivers explained this improved smoothness by the slight increase in weight and the more even weight distribution of the steam bus. Two of the drivers mentioned a "smoother shifting transmission" as adding to the increased smoothness.

The drivers' opinions concerning the relative power of the steam bus were more varied than on other issues. Responses ranged from "it [steam bus] has more power all the way through than the diesel bus does" to the feeling that the steam bus has "less power because of less horsepower", with three of the five interviewees indicating that there is less power on the take-off. Two of these three drivers did, however, seem to feel that the steam bus does have more power after shifting gears.

When asked about the odor produced by the steam bus, all five drivers emphatically agreed that there is "a lot less odor". In general, the drivers were enthused about this noticeable difference in odor because it makes travelling on a steam bus "that much nicer to ride" for both themselves and their passengers.

Once again, the steam bus operators were in agreement in their observations -- this time on the question of smoke. All five drivers felt that

considerably less smoke was emitted from the steam bus than from diesel buses they had driven.

The drivers were also asked to comment on the safety of the steam bus in comparison to the diesel. They felt that there was no difference in the safety factor of the vehicle itself for the passengers, except for one driver who commented that "It would be harder I would say to clear an intersection. . . you can't take off as fast." Three of the operators pointed out that safety is dependent "mostly [on] the man behind the wheel". It is interesting to note, however, that three of the drivers did mention that the buses could be considered safer, to the general public, in terms of the reduction in pollutants they emit.

When questioned on the effect steam buses will have on pollution, all of the drivers had much to say, indicating their concern over air pollution and their hopes for steam. The general feeling among the drivers was that if steam buses replaced diesel buses there would be "considerably less" air pollution; e.g., one driver stated, "I think they're on the right track as far as cleaning up the air is concerned." Four of the five operators did cite the automobile, however, as the major producer of air pollution.

From their experiences, all of the drivers felt that the steam bus handles "very much the same" as the diesel buses they usually drive. While two of the five did mention that steering is "a little harder", none of them noticed any difference in the stopping distance of the steam bus.

When asked about learning to operate the steam bus, "adjustment rather than real difficulty" was reported by the five drivers. Three of the drivers referred to the different gauges they needed to watch, while two of the drivers pointed out starting the bus up as "a slight problem". An average of three hours of training was given to each of the operators. They were accompanied

on their runs by their instructor and/or a crew of engineers who usually started up the bus.

When asked to comment on their passengers' reactions to riding on a steam bus, all of the drivers noted that there was general interest and that the public had a lot of questions. While a few riders were not aware that they were riding a steam bus, many had read about it in the newspapers. One driver reported that "they [the passengers] would let the diesel buses go by and wait for the steam bus. I had people hanging out the windows almost, just to get a ride on the steam bus. People went out of their way to take the steam bus. They enjoyed it."

We also questioned the drivers about which bus -- the steam or the diesel -- they would prefer driving on a daily basis. All five of the drivers indicated that they prefer the steam bus because it provides a smooth, quiet ride and is a less polluting vehicle, but with some improvements. It was their general feeling that it will be difficult "to maintain the schedules that we have with the steam bus the way it is set up now. . .With improvements and if the performance standard were brought up to what our diesels are, I'd prefer the steam bus."

A second interview was conducted with one of the drivers of the Brobeck bus after several changes of that bus were made. The changes were so dramatic that our driver told us, "I completely forgot that I was driving a steam bus -- we were moving along that smooth." He noted considerable improvement in the noise factor, the power, the odor and the overall handling of the bus as well as the smoother ride. The enthusiasm of the passengers matched that of the driver; according to the driver, "the passengers said they hoped to ride the steam bus in the future -- the really liked it."

All five of the drivers interviewed were quite cooperative and, in fact, eager to share their experiences and opinions. The attitude these drivers took towards the steam bus ranged from that of "it's just another job" to one driver who even dreamt about the steam bus, and made a special effort to see it safely out of the barn on days when he wasn't operating it. Four of the five drivers mentioned that they felt it an "honor" to be selected to drive the steam bus -- they felt they played a "special role in history".

Modern features on the steam bus, such as the carpeting on all of the buses and music on the Brobeck bus, noticeably changed the attitude of both the passengers and the drivers. One of the drivers informed us that driving a cleaner, more modern bus "makes a lot of difference in the attitude the people take toward the driver." He went on to inform us that "It gives you a little different feeling to know that you're going to be on the steam bus." The drivers also expressed some concern that the public was unjustly impatient with the progress of the steam bus. One of the drivers summed it up by saying, "I don't think these people have had enough time to get all the bugs out of their engine; I don't think General Motors built their engines in 18 months and perfected them." I think in all fairness to these people that we should have more time, and from what I've seen, I think that they could make the thing work if they had the time and the money of course to do it. I'd like to see it".

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