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REVIEW OF RAPID TRANSIT SAFETY

DECEMBER 1977

LEGISLATIVE ANALYST

STATE OF CALIFORNIA

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INTRODUCTION

The Supplemental Report of the Conference Committee on the Budget Bill of 1977 recommended that the Office of the Legislative Analyst assess the role of the Public Utilities Commission (PUC) in reviewing the safety of the Bay Area Rapid Transit System (BART).

This report includes (1) an assessment of the role which the PUC performs with respect to regulating BART safety, (2) a review of current and anticipated expenditures for safety, both by the PUC and by BART and (3) recommendations on staffing and funding for future performance of the safety function concerning local rapid transit districts.

This report was prepared by James Cooney and Robert McCleary under the supervision of William Behnk.

SUMMARY OF RECOMMENDATIONS

Based on our examination of the Rapid Transit Systems Section of the Public Utilities Commission (PUC) we make the following recommendations.

We recommend that:

1. The permanent basic staffing level of the Rapid Transit Systems Section include (1) a "working" manager, (2) a section secretary, (3) an electronic systems specialist, (4) a railroad operations specialist, and (5) a maintenance/reliability specialist.
2. A computer systems specialist be retained by the PUC through 1980-81 to review the replacement of BART's computer systems.
3. One additional staff specialist be retained to review BART through the 1978-79 fiscal year, only.
4. If safety review of SCRTD rail transit operations becomes necessary, three personnel be added to the basic staffing level of the Rapid Transit Systems Section.
5. PUC jurisdiction concerning safety review of rail rapid transit systems be extended to all operators of such systems in California. This would include jurisdiction over the proposed Los Angeles people mover.
6. The portion of Section 29047 permitting BART reimbursements for PUC regulation be repealed.
7. The general question of equity in regulatory funding be addressed, and payments to the General Fund by all regulated agencies including BART be considered to defray a portion of regulatory costs.
8. A comprehensive safety analysis be conducted by each rail rapid transit system utilizing a systems approach.

9. Each operator of rapid rail transit service undertake a program of internal safety audits to promote the safety of daily operations.

10. The BART Safety Department assume primary responsibility for assuring that adequate safety analyses are conducted by the district.

I. HISTORICAL BACKGROUND

The Bay Area Rapid Transit District (BART) ". . . shall be subject to regulations of the Public Utilities Commission relating to safety appliances and procedures, and the commission shall inspect all work done pursuant to this part and may make such further additions or changes necessary for the purpose of safety to employees and the general public."¹

The commission's jurisdiction was extended to cover rail transit operations of the Southern California Rapid Transit District (SCRTD) in 1964, and of the Santa Clara County Transit District (SCCTD) in 1969.² Currently only BART operates rail services. SCRTD and the City of Los Angeles have proposed a rail transit "starter line" and a people mover guideway system, but only preliminary engineering studies are underway at this time. Consequently, commission activity is currently oriented almost exclusively to BART.

REGULATION OF BART SAFETY

Commission review of BART safety was handled within the Railroad Operations and Safety Section of the commission until 1975. Personnel from this section were assigned on a part-time basis prior to the initiation of BART revenue operations in September 1972. A major accident in Fremont following the initiation of passenger service led to a PUC hearing and investigation. Early in 1973, two

1. State of California, Public Utilities Code, Sec. 29047.

2. State of California, Public Utilities Code, Secs. 30646 and 100168.

personnel from the section, an electrical engineer and a railroad operations specialist, were assigned full-time to review BART, and this staffing level continued until mid-1975.¹

1975 to Present

In January 1975, several major incidents occurred including a fatal collision of a BART maintenance vehicle with a BART train, and a collision of trains in the Concord yard. Continuing technical and operational problems within the district warranted a further expansion of PUC personnel and the Rapid Transit Systems Section was established in July 1975. Staffing was expanded from two to six full-time personnel to facilitate more comprehensive and detailed safety review. New staff included a manager, secretary, computer systems specialist, and another electrical engineer. These four positions were authorized on a temporary basis and two additional technical consultants were retained to assist the section staff, a control systems specialist and a reliability/quality control specialist. In the 1977-78 fiscal year, the two consultant positions were added to the section on a temporary basis resulting in eight authorized positions. Currently, seven personnel are employed and the control systems specialist position is vacant.

Impact of the PUC

In recent years, BART has compiled a good overall safety record, due in part to PUC activities. The commission has taken an active

1. For an extensive history of PUC involvement with BART, see California Public Utilities Commission, Rapid Transit Safety Regulation Activities (November 1977). Hereafter cited as PUC, Safety Regulation.

role since 1972 and issued a number of orders to BART detailing various requirements to be met before specific passenger services could be provided.

The first major PUC action occurred in 1972 before the BART system was to open for revenue service. At that time, the commission required an acceptance test for the train detection and control system. Under certain conditions, this system failed to detect adequately the presence of trains on the system. Accordingly, the PUC required a manual system to assure adequate separation between trains.

This train separation function was subsequently taken over by the Computer Augmented Block System (CABS), following PUC approval of the change, and a modified version of CABS is still in use today to insure adequate train separation. Various technical changes to CABS were required in 1974 before transbay BART operation was permitted. CABS must be replaced with a more advanced system, the computerized Sequential Occupancy Release System (SORS), before the next major service increment (the addition of direct Richmond-Daly City service) can be added.

The PUC has also been concerned with BART reliability and equipment problems regarding the propulsion, braking, train operations, and computer systems. The conclusion of the commission is that major changes will be necessary in each of these areas to achieve a high level of reliability. Reliability and related problems affecting safety have received special attention since the January 1975 accidents. Commission investigations subsequent to the accidents resulted in issuance of several safety orders to BART which impacted reliability. These orders required changes in operations, equipment and procedures.

OTHER SAFETY REGULATION

Limited activity by the commission has been required for safety regulation of rail transit operations other than BART.

In Los Angeles, SCRTD is studying the feasibility of a rail transit starter line and the City of Los Angeles is investigating a downtown people mover system. The commission is currently monitoring these proposals and will become more involved if the proposals move forward. A document "Rules and Regulations for the Design, Construction and Operation of Light Rail Transit Systems" has been prepared pursuant to Public Utilities Code Sec. 778 which requires the PUC to establish such rules.¹

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1. Light Rail Transit is typically defined as a mode of urban transportation utilizing predominantly reserved but not necessarily grade-separated rights-of-way. For example, streetcars can be considered one example of light rail transit.

II. COMMISSION ROLE AND STAFFING

The mandate for PUC safety regulation of rail rapid transit systems is unusual both in nature and scope. Most other systems in the country, including Boston, New York, Chicago, Washington, and Atlanta, are not subject to close scrutiny concerning safety by an agency such as the PUC. It is also unique for an agency such as the PUC to be able to make changes necessary for the purpose of safety, but BART's operating experience and the performance of the commission to date clearly demonstrate the value of this regulation, and BART is supportive of the PUC regulatory function.

However, unresolved issues concerning this regulation remain, and include (1) identifying the precise role of the PUC, (2) determining the level of necessary staffing, and (3) deciding who should pay for the regulation.

DETERMINING THE PROPER ROLE

Review and Audit

Within its responsibility for the regulation of safety, the PUC acts as both reviewer and auditor. It reviews district safety analyses, operating procedures, and proposed operating changes to assure adequate attention to safety. It also audits the safety of operations to verify that daily operations reflect adequate attention to safety.

Commission review should be facilitated by the transit operator. Responsibility for performing safety analyses, providing safe operating procedures, and developing a safe system are clearly operator functions.

The commission should have information available from the operator permitting it to examine safety issues, comprehensively. This can be accomplished if the operator adopts a comprehensive systems analysis approach to safety and produces appropriate documentation, as we recommended in our October report concerning "BART Capital Program Requirements."¹

For BART, the review function is very important with regard to proposed system changes. For example, the "close headways" program to permit expanded district services is receiving careful review, and the commission may use its authority in this instance to prohibit service changes until it is confident that the changes are safe.² It may reject proposals which lack a comprehensive framework and adequate supporting detail for those reasons alone. Demonstrating that the changes are safe and providing adequate supporting information is totally the responsibility of the district.

Auditing is primarily important for daily operations. The commission should monitor to see that the district utilizes safe operating and maintenance procedures and that potentially unsafe conditions are resolved.

In both review and audit, the PUC should attempt to separate the important issues from those of lesser significance. Therefore, the district and the commission should identify the relative importance or sensitivity of various aspects of operations and concentrate on them.

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1. Office of the Legislative Analyst, BART Capital Program Requirements (October 1977). See pp. 11-14, 19-20. Hereafter referred to as Legislative Analyst, BART Capital Program.
 2. The close headways program elements are designed to permit BART trains to run with shorter time intervals on the order of 3 minutes between trains.

Safety Standards and Criteria

To facilitate safety analysis by the district, the commission should set safety standards where possible and indicate criteria that will be used to evaluate the adequacy of the district's safety analysis. This would provide guidelines for the district and promote more effective safety analyses of systems and programs. This was briefly discussed in our October report.¹

For example, safe train separation must be addressed before the BART "close headways" program can be implemented. At issue are (1) the safe operation of the equipment involved in close headways, including SORS, train control and braking equipment, and (2) the adequacy of any "model" used to represent train movement characteristics, including train speed determination and stopping attributes. The PUC should indicate that it desires this information to be systematically compiled, and integrated to provide assurances that the system will be protected from collisions. A numerical standard specifying the acceptable probability of collision may not be possible to generate,² but there must be a high level of confidence that collisions are extremely unlikely. This approach can also be taken regarding review of other programs and the audit of operations. In this regard the PUC should indicate the general framework for analysis and the type of information desired with the district providing the required information.

1. Ibid., pp. 11-14.

2. See PUC, Safety Regulation, pp. 5.3-5.4, for a brief discussion of this issue.

Making Changes

Under the statutes, the commission may also require additions or changes necessary for the safety of employees and the general public. In the past, the commission has required numerous changes at BART including such details as the addition of handrails inside the cars and signs warning patrons of potential hazards.

While it was necessary under past conditions for the commission to make such detailed recommendations, this should be considered a last recourse. It is more desirable for the commission to indicate functional changes it believes are necessary at the program level. BART should then select the alternative to accomplish the function, subject to PUC approval. To the extent possible, the PUC should confine its role to regulation, and give as much implementation responsibility as possible to a local operator such as BART.

SECTION STAFFING

The Rapid Transit Systems Section has eight authorized positions, with seven currently filled. In our view, there should be three categories of staffing in the section: (1) basic, (2) extraordinary requirements for BART, and (3) future potential needs.

Basic Staffing

A permanent basic staffing level is required to examine light rail transit problems, monitor and review rail transit proposals made by SCRTD and SCCTD, and review and audit BART.

Recommendation

We recommend a permanent basic staffing level of five personnel

for the Rapid Transit Systems Section. This would include (1) a "working" manager, (2) a section secretary, (3) an electronic systems specialist, (4) a railroad operations specialist, and (5) a maintenance/reliability specialist.

The section requires a working manager who involves himself in some review activities and monitors SCRTD and SCCTD. The three technical specialists should include an electronics systems specialist to review BART electronic components and systems utilized in operations. This position would insure that systems are subjected to adequate safety analyses and integrated from a safety standpoint. The operations specialist would review operating conditions and procedures, including industrial safety. The maintenance/reliability specialist would review maintenance, quality control, and reliability as they relate to safety.

Extraordinary Requirements at BART

Beyond the basic staffing level, BART's requirements make certain additional personnel necessary. A computer systems specialist will be required at least through 1980-81, and one other position is needed through 1978-79.

Through 1980-81

We recommend that a computer systems specialist be retained by the PUC through 1980-81 to review the replacement of BART's computer systems.

BART is in the process of replacing its various computer systems with a more integrated and effective overall system. The computer systems supervise and monitor operations, and will also be utilized in monitoring maintenance in the future. Operations of these systems

are closely related to safety. The computer replacement is currently slated to extend through 1980-81.¹ Therefore, the PUC should have one specialist dedicated to this project through that time period. This specialist would continue to be needed beyond 1980-81 if the computer replacement project is not completed.

1978-79

We recommend that one additional staff specialist be retained to review BART through the 1978-79 fiscal year, only.

Retaining this additional staff specialist (presently within the unit) is warranted because of the extraordinary circumstances at BART. Currently efforts are underway to resolve major BART technical problems within a two year period. By July 1979, completion of these major changes is anticipated: (1) propulsion motor, air conditioning, door, braking, and Automatic Train Control modifications to BART's transit vehicles, and (2) major changes and improvements in the train storage yards and along the right of way.² The lack of systematic plans and safety analyses to date for these changes require more detailed commission review than the basic staffing level can provide. In addition, BART is considering implementing before June 1979 the only major service increases presently contemplated. The additional staff person will be necessary to conduct this review through 1978-79.

1. Ibid., pp. 27-28.

2. Ibid.

PUC Anticipated Expenditures

The Rapid Transit Systems Section is currently funded for two permanent and six temporary positions. Anticipated expenditures for the section at this staffing level for both the current and the budget year are shown in Table 1.

TABLE 1
PROJECTED EXPENDITURES FOR THE
RAPID TRANSIT SYSTEMS SECTION

<u>Expenditures</u>	<u>1977-78</u>		<u>1978-79</u>	
	<u>Personnel Years</u>	<u>Cost</u>	<u>Personnel Years</u>	<u>Cost</u>
Personnel Services	6	\$160,411	8	\$237,801
Operating Expenses	<u>2^a</u>	<u>121,243</u>	<u>-</u>	<u>28,160</u>
	8	\$281,654	8	\$265,961

a. Includes funding for two consultant positions.

We recommend seven personnel-years rather than eight in 1978-79. Elimination of the currently vacant position would reduce anticipated 1978-79 expenditures approximately \$34,250 to \$231,711. Reducing the section to six in 1979-80, by eliminating another position funded at a lower salary, would result in a further reduction in expenditures of \$30,030 from the 1978-79 level. These reductions will be possible unless the activities at SCRTD increase significantly as discussed below.

Future Requirements

Work is currently proceeding at SCRTD on preliminary engineering for a "starter" rail rapid transit line in Los Angeles. Actual

implementation of such a proposal is dependent upon a variety of factors and is uncertain at this time. A related proposal under study is a downtown Los Angeles people mover guideway system. This latter system may not be subject to PUC regulation if constructed because it could be operated by an entity other than SCRTD.

If the starter line is constructed and/or the people mover is built and operated by SCRTD, review by the PUC will be necessary. In our judgment, three additional personnel to review transit operations in Los Angeles would then be required.

Recommendation

We recommend that if safety review of SCRTD rail transit operations becomes necessary, three personnel be added to the basic staffing level of the Rapid Transit Systems Section.

Because PUC regulation of safety at BART has been beneficial, it could also assist with regard to either SCRTD or SCCTD, should those systems implement rail rapid transit service. However, the lack of PUC jurisdiction in other areas, highlighted by the uncertainty of PUC review concerning the Los Angeles people mover, merits careful legislative review. We believe PUC jurisdiction should be extended to any rail rapid transit system developed within the state.

Recommendation

We recommend that PUC jurisdiction concerning safety review of rail rapid transit systems be extended to all operators of such systems in California. This would include jurisdiction over the proposed Los Angeles people mover.

PROGRAM FUNDING

The Rapid Transit Systems Section of the PUC is currently financed from the General Fund. However, under provisions of Chapter 1089, Statutes of 1975, the state may charge BART for other staff and related costs which are not financed from the General Fund. Since 1975, BART has paid approximately \$85,000 in such support.

The statute does not place limitations on the amount of reimbursement which can be collected from BART, but declares that costs not defrayed from the General Fund may be so charged. The Department of Finance is the final arbiter in determining what BART should pay for regulation costs incurred beyond the level budgeted from the General Fund.

This statute was enacted on an urgency basis to fund consultant services and travel expenses required by the PUC following the January 1975 accidents and prior to establishment of the Rapid Transit Systems Section. It was applied through the 1976-77 fiscal year to fund consultant and travel costs. The district contested reimbursement (proposed at a higher level) for 1977-78, and the Legislature eliminated it from the budget. Thus for 1977-78 the entire unit has been funded from the General Fund, in contrast to the original budget proposal which provided for reimbursement by the district of four section positions and two consultants.

Desirable Changes

Current law permitting BART reimbursement served a useful purpose when it was enacted. However, that urgent need has been met, and the provision is now in question. For example, it is not clear what measures should be applied to determine the appropriate

level of BART reimbursements. This leads to uncertainty regarding program activities, because funding for staff can be subject to negotiations between the PUC, BART, and the Department of Finance.

Furthermore, the law is not equitable because a similar provision is not included in either SCRTD or SCCTD legislation. Finally, while highway freight carriers pay into the Transportation Rate Fund to defray part of the cost of their regulation by the PUC, similarly regulated railroads and utilities do not. In the 1977-78 Analysis of the Budget Bill, we recommended that this equity question be resolved by having all regulated bodies pay into the General Fund amounts to partially offset the cost of regulation.¹

Recommendations

1. We recommend that the portion of Section 29047 permitting BART reimbursements for PUC regulation be repealed.
2. We recommend that the general question of equity be addressed, and that payments to the General Fund by all regulated entities including BART be considered to defray a portion of regulatory costs.

1. Office of the Legislative Analyst, Analysis of the Budget Bill (February 14, 1977), pp. 984-5.

III. TRANSIT OPERATORS

The responsibility for providing safe transit service rests with the individual transit operator. The operator has a responsibility to perform analyses which factually demonstrate that the system is adequately safe. As discussed in the previous chapter, it is the responsibility of the PUC to review such analyses and approve services only when it judges the analyses to be adequate. It is also the responsibility of the PUC to audit service and curtail unsafe practices.

The individual transit operator must address two aspects of safety: (1) safety analysis, and (2) safety audits. We shall briefly discuss each, and then discuss on-going safety efforts of BART as a specific example.

RESPONSIBILITIES

Safety Analysis

An extensive safety analysis should be a fundamental part of the planning and development process for rail rapid transit systems. This analysis should be comprehensive and utilize a systems approach which identifies the major components of the operating system, and analyzes the interactions among them. We have called for this type of analysis at BART,¹ and the district is currently preparing a plan which we anticipate will represent an adequate safety analysis approach for proposed new services.

1. Legislative Analyst, BART Capital Program, pp. 13-14.

Safety analyses of necessity will consist of three processes: (1) descriptions of interactions, (2) quantitative analysis, and (3) application of judgment factors. Unfortunately, it is not possible at present to analyze statistically the overall safety of a system; therefore, judgment factors are a significant part of the process.

However, the transit operator does have the responsibility to assess the safety of the system thoroughly and, where possible, quantitatively. For example, one of the most critical requirements is to avoid collisions by providing for safe train separation. This entails insuring the adequacy of: (1) operational parameters and reliability for equipment such as that used for train control, protection, and braking, (2) the "models" used to define train movement characteristics and the translation of these models into quantitative assessment of operations, and (3) safe procedures for resolving potentially hazardous conditions which might arise.

Recommendation

We recommend that a comprehensive safety analysis be conducted by each rail rapid transit system utilizing a systems approach.

Safety Audits

The operator also has a responsibility with regard to safety audits. The safety of daily operations and maintenance must be continually monitored by the operator. BART currently has an auditing program. Changes in operations and maintenance should be made where

the audits indicate they are required for safety. Furthermore, the PUC should evaluate the adequacy of the operator's monitoring program, perform independent audits as necessary, and require additional changes when justified for safety reasons.

Recommendation

We recommend that each operator of rapid rail transit service undertake a program of internal safety audits to promote the safety of daily operations.

BART SAFETY DEPARTMENT

To meet the requirements imposed by the PUC and fulfill its obligations in the safety area, BART established its Safety Department in 1975. This unit is responsible for insuring that adequate safety analyses are conducted at BART, and for auditing BART's day-to-day safety. Safety analyses for proposed system changes such as for "close headways" are prepared by the engineering department and then reviewed by safety.

Expenditures

Only the expenditures of the Safety Department were reviewed for purposes of this report. It was not possible to compile information on safety-related expenditures by other departments.

The Safety Department has 14 positions budgeted for the current fiscal year. In addition to the department manager and secretary, six positions are budgeted for industrial safety and six for systems

safety. Budgeted salaries and benefits for the unit total \$417,127, and nonlabor expenses including consultant contracts total \$115,580 for an overall budget of \$532,707.

Potential Changes

We have pointed out that BART has not yet performed the systematic and comprehensive safety analysis necessary to substantiate planned changes. At present, the district is preparing part of a plan for such an analysis of the "close headway" program. However, responsibility for such an analysis currently rests with the engineering and operating departments.

In our view, there would be some benefits from placing the responsibility for preparing safety analyses with the Safety Department. The department could more objectively assess the safety of proposals made by other departments. Furthermore, the Safety Department should be better able to provide the comprehensive view necessary for adequate analysis.

Recommendation

We recommend that the BART Safety Department assume primary responsibility for assuring that adequate safety analyses are conducted by the district.