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April 5, 1996

TO: BOARD OF DIRECTORS

FROM: RAE JAMES

SUBJECT: GRAND JURY REPORT

ISSUE

The Los Angeles County Grand Jury recently released a report that evaluated the MTA's rail construction quality assurance program. The Grand Jury reported that the MTA's quality assurance program was "on the right track." Attached is a copy of the report.

BACKGROUND

The Grand Jury began its investigation last August as part of its good government oversight role and in response to several MTA construction incidents which gained national notoriety.

The panel found that the MTA has developed policies that have become a standard for the rail construction industry and the MTA procedures are competent, conservative and follow generally accepted quality guidelines. They also noted that much of the MTA's Quality Program manual has been adopted by the Federal Transit Administration.

Even though the panel did not investigate safety they did address safety issues as part of quality assurance. The report notes that "....on every occasion, we found safety issues considered, and in the field adequate safety procedures in use."

The Grand Jury concluded that the MTA has developed a strong quality assurance program, staffed with competent individuals willing to face hard issues. The report concludes that "....as evidenced by the engineering/management people involved in the project, in our opinion MTA is on the right track...."

If you should have any questions regarding this report, please do not hesitate to contact me.

Prepared by: Gary Clark, Assistant Director Government Relations

Attachment

RJ:GC:chm\a\agendalanguage:grandjuryboardbox

Evolution of Quality Control
Metropolitan Transportation Authority
Rail Construction

January 6, 1996
1995-96 Los Angeles County Grand Jury
Transportation Committee
Final Report

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Evolution of Quality Control Metropolitan Transportation Authority Rail Construction

Quality Assurance Program

1. Authority for Study

The Superior Court "charge" to the Los Angeles County Grand Jury each year includes the requirement for the Jury to provide civil oversight of County operations with a view toward improving the efficiency and value of those operations for the citizens of Los Angeles County. The Jury has organized itself into committees to allow it to address a number of County areas during its term. One of the constituted committees for 1995-96 is the Transportation Committee. The Transportation Committee was aware of questions raised in the press regarding the quality of construction achieved by the Metropolitan Transportation Authority (MTA). By on-site observation the committee was also aware that significant portions of the new Metro rail system are open to the public and operating in a safe and efficient manner.

It was also clear to the committee that the MTA rail construction is a massive effort using many technologies and presenting many problems, some of them unique. Incidents will arise from time to time, some getting excessive public attention. The committee decided to ask the Grand Jury for authority to study the quality assurance methods employed by the MTA to assure safe, cost-effective functional construction and operation of the new rail system being created for the citizens of Los Angeles County. Prior to requesting Grand Jury approval for the study, the committee requested the opinion of the Office of the County Counsel, County of Los Angeles, as to the authority of the Grand Jury to investigate the Metropolitan Transit Authority Light Rail Construction Project. On July 21, 1995, the response to our request read in part, "... It is our opinion that the Grand Jury has the authority to examine the books and records and investigate and report upon the method or system of performing the duties of the MTA. The specific issues you indicate you are interested in are within that authority...."

The Transportation Committee began the prescribed study on August 1, 1995, with concluding information being received in December.

2. Background

The MTA is a consolidation of several predecessor agencies charged with public transportation within Los Angeles County. The MTA operates "The Metro" which includes buses as well as rail. The Blue Line, Green Line and operating first segment of the Red Line are expected to carry nearly 20 million passengers in FY 1995. Cost of rail construction to date for operating segments is in excess of $3 billion. Cost of rail still under construction is expected to exceed $4.5 billion, which currently approximates $3 million per day. While the development of such an extensive rail system is an appropriate topic for Grand Jury oversight, the issue then becomes how to limit the study to an area that can be completed within a reasonable period. In addition, because a significant number of other studies and audits have been accomplished, we had no wish to duplicate these.

We reasoned that impact on the citizens of Los Angeles of the new rail system would be affected by their perception of the quality control and safety of construction of the project. Therefore, ***we directed our study to the quality assurance methods employed by the MTA in assuring safe, cost-effective construction and operation of the new Metro rail system.***

Definition of quality assurance for the purposes of this study is those policies, procedures, personnel and activities needed to monitor fully and control the

implementation of the design and engineering of the rail system into a finished project meeting all design, governmental and safety requirements.

Topics considered:

a. Formal policies and procedures governing quality assurance, quality assessment and inspection of construction.

b. Lines of authority in the quality maintenance organization to implement policies and procedures.

c. Relation of quality control issues between projects and sub-projects, Los Angeles County and other government agencies.

d. Review of confirming documentation, inspection reports and corrective action reports.

3. Areas Excluded from Study

MTA is a large organization made up of parts inherited from predecessors as well as parts that have been created by the expansion of function. **However, we excluded all areas not concerned with the quality assurance program being applied to new rail construction.** This excluded such topics as buses, real estate development, office buildings, management organization, technical decisions, cost projections, cost decisions, rail operations, legal and political issues. We had planned originally to study the safety program as well as quality, but narrowed our study to penetrate enough depth and arrive at a reasonable understanding of the status quo and how it came into being. *Note: Even though we did not specifically investigate safety, we did encounter safety issues as part of quality assurance. On every occasion we found safety issues considered and in the field adequate safety procedures in use.*

4. Sources of Information

All information was supplied by members of MTA rail construction quality and engineering staff. Information also came from documents in the files of the MTA or prepared by MTA staff to address our questions. We gained further information and understanding through face to face meetings with the staff. In addition, we traveled to a site to view firsthand underground construction at a tunnel face and took a short ride on the Red Line for a taste of the finished product. Our process during the study was to ask questions based upon our understanding of modern quality assurance techniques. Information received raised further questions. We then repeated the process. While this process is not without risk of missing a major point, we believe we have obtained a reasonable understanding of the practices in use by the MTA. We did not attempt to audit the efficacy of the information being supplied.

We wish to thank the MTA staff who provided us with information in an open and straightforward manner. No quality program can ever be successful unless those involved are willing to deal truthfully with the issues involved. The MTA staff who worked with us appeared willing to give us the whole story. Their approach built confidence in their quality and engineering personnel.

5. Structure of Report

We present an overview of the rail construction. We follow with a discussion of two diverse types of approach used for major construction projects, both of which have been applied to the evolution of the new rail system. Then we follow with our view of the evolution of the quality assurance program for MTA rail construction from pre-World War 2 methods (based upon limited control of materials and processes and few engineering disciplines involved) for the initial construction through joint MTA/Caltrans quality methods evolving toward post-World War 2 methods (based upon effective control of materials and processes and multiple engineering disciplines involved) to its present state.

To complete our report, we consider existing quality assurance policies and procedures; inspections and inspectors; audits and surveillances; people and organization; reporting of status and trends; and finally the effectiveness of the quality assurance program. We offer some observations and recommendations and make a brief summary.

6. Overview of Rail Construction (see Chart 1)

Chart 1 is an overview of the various Metro segments which have been built or are under construction showing the quality issues for each segment. The chart indicates there has been an evolution from less formal quality assurance to more formal quality assurance with time.

The "quality policy" for the Rail Construction Corporation (RCC), construction subsidiary of MTA, was published April 1991 and confirmed in the November 1993 revision. It provides for strong internal quality assurance management. This policy shifts responsibility for control from management subcontractors to MTA personnel.

7. Developing Quality Assurance Construction Methodologies

a. Pre-World War 2 Construction Methodology

Prior to World War 2, major construction for railroads, bridges, etc., was designed in a manner that took into account the difficulty of getting predictable materials and having predictable construction techniques. Elements such as steel cable strength and rivet temperature were difficult to predict or control. As a result, engineers used large margins of safety to account for these unknowns and then inspected to the extent possible to control process. This method produced successful results, which were often outstanding (the Brooklyn Bridge is an example). But the projects were often more expensive, and rework required late in the project could cause delays as well as added cost. This process works best for jobs that employ relatively few technologies and that have simple interfaces (such as the Long Beach Blue Line).

b. Post-World War 2 Construction Methodology

After World War 2, technology became more complex and the ability to control materials and processes grew at an incredible rate. This allowed engineers to employ new techniques that included quality assurance steps to verify materials and processes. With design tolerances closer and continuous control of nonconformance, costs and schedules were reduced. This method is best used for complex projects with multiple disciplines (like the Red Line) and requires quality control functions independent of engineering so that construction issues are viewed in real time.

8. The Evolution of Quality Assurance for MTA Rail Construction

Identifying some work on the rail system as pre-war quality assurance and some as post-war quality assurance oversimplifies the issue; however, it does provide a useful framework for analysis.

Construction of the Long Beach Blue Line used pre-war techniques. It has relatively few technical interfaces and relies on proven techniques. Operation of the line shows it to be reliably and competently built. The Green Line started using pre-WW 2 techniques, but since the line was part of a new freeway project, Caltrans requirements were added. This increased the QA requirements significantly and elevated the Green Line above the older methods.

The start of the Red Line also used pre-WW 2 methods, but as a much more complicated project, it required new methods. This became apparent reasonably early, and MTA began moving management contractors toward post-WW 2 quality work plans. Independent quality assurance, audits and surveillances and the ability of anyone to open a nonconformance

report for investigation started in 1990 and have been maturing ever since. This approach appears to be working well. In 1990 MTA also developed a set of quality assurance policies that have since become a standard for the rail construction industry.

From 1990 to 1994 the MTA quality assurance oversight was provided QA by a QA contractor. In 1994 MTA began to establish an in-house QA capability by seconding contractor personnel. In mid-1995 the in-house program was endorsed by the new MTA construction executive. As of September 1995, MTA has 17 quality assurance people on staff. This move strengthens the long-term quality control effort. Since internal buildup has been at the expense of contractor expertise, it will take some time for the contractors to replenish their QA capability. The transition to in-house should be complete and fully effective in a year to eighteen months with continuing MTA management support.

9. Quality Assurance Policies

In 1991 MTA produced a Quality Program Manual which was later revised in 1993. Much of that manual was adopted by the Federal Transportation Administration as a standard for the industry.

The Quality Program Manual is an impressive document, covering policies and procedures for a multitude of disciplines. The manual is conservative and shows real intent to produce and verify quality construction.

10. Quality Assurance Procedures

In our opinion, MTA and their management contractor's procedures are competent, conservative and follow generally accepted Quality Guidelines. A management contractor serving the MTA, Parsons-Dillingham, has developed guidelines for control of nonconforming items. Nonconforming items include such items as bad welds, improper liner installation, tunnel misalignment, electrical work not up to code, out-of-specification materials, etc. The guidelines represent not only an important control manual but also shows general procedure format and content.

11. An Example of the Evolution and Use of a Nonconformance Report

A primary quality assurance control document is the Nonconformance Report (NCR), which documents significant deviations from expected procedure or process. To provide better understanding of the use of the NCR, NCR 95-162 shows the chronology of events that lead up to the report and tracked it to its conclusion as follows:

On January 4, 1995, the Daily Inspection Report (DIR) for the Vermont Tunnel indicated a thin arch in the concrete just poured and a void (5' x 5') in one of the tunnels. The next day NCR 95-162 referenced the DIR. This NCR was created in a timely manner per procedure. On January 9 the NCR was transmitted to the tunnel contractor for analysis and action, again per procedure. On January 13 an appropriate response was received from the contractor. Engineering discussions between January 13 and February 10 followed this report to find the right solution. Then intervening work caused delay in the rework which was not unexpected. The quality assurance control oversight was maintained throughout this process and not closed until the repair work had been accomplished as required by engineering and passed inspection. All of the procedures were standard and effective despite negative publicity surrounding the event.

12. Inspection and Inspectors

Inspection takes place at all levels of construction organization. The contractors have inspectors, the management contractors have inspectors, as does the MTA. There are also independent testing laboratories inspectors both on- and off-site. MTA encourages the education and certification of all of the inspectors working on the rail construction project. MTA's Quality Control Inspector Training Program has been successful in upgrading the expertise of their inspectors.

13. Audits and Surveillances

Audits and surveillances are a key part in any post-WW 2 quality assurance effort. Properly done, these methods confirm system quality while at the same time uncover issues that can be dealt with in a timely manner prior to the full review that accompanies final certification for revenue operation. Listed below is the number of audits and surveillances completed from 1985 to October 1995:

Year	Audits	Surveillances	Total
1985	2	0	2
1986	2	0	2
1987	9	12	21
1988	2	33	35
1989	12	40	52
1990	5	41	46
1991	4	6	10
1992	22	42	64
1993	39	35	74
1994	48	17	65
1995	20	103	123

14. People and Organization

The MTA has been slowly building an in-house quality assurance staff to balance the construction management contractor's quality control staff. MTA started this effort in 1991. After the change in construction management at MTA in mid-1995, staffing efforts in quality assurance have been stepped up with 17 personnel on board by the end of the third quarter. This increase includes a new Director, Quality Management, who reports directly to the executive in charge of construction. MTA plans to continue to use a significant amount of construction management contractor effort for quality control and inspection throughout all construction. The internal buildup is meant to shift authority for implementation of quality assurance to MTA where the final responsibility already resides. The personnel staffing plan, coupled with the rather impressive internally generated quality policies, gives optimism about the evolution of a disciplined quality assurance program. Now that internal QA staff is on hand, the contractors are rebuilding their quality support staffs and clear lines of authority have been established. The remaining need is the development of a management tracking system, identifying items in the control system before they erupt into major problems.

15. Reporting Status and Trends

We observed that information is being collected and trends measured by computer of the nonconformance reports as well as the audits. However, it is not clear that this information is being produced on a regular basis or that it is being given sufficient attention from MTA construction management.

16. Growth of Quality Assurance Program and Effectiveness (see Chart 1)

Our study indicates a growth of both quality assurance awareness and support over the years by MTA management. The rate of this growth has been affected by budgetary issues as well as the evolutionary nature of the MTA itself. Since 1990 a conservative and disciplined program has been growing.

17. Observation and Recommendations

Observation: ***A quality assurance program exists to provide control, independent feedback and timely information to the engineers and managers responsible for the successful, reliable completion of the rail project. To accomplish this purpose, the program is staffed with competent individuals willing to face hard issues with the intent to supply information to those that use it to the best advantage of the system being built. As evidenced by the engineering/management people involved in the project, in our opinion MTA is "on the right track."***

Recommendation: ***As rapidly as possible, create the final portion of the quality assurance system, the management tracking of unexpected events and open issues. At a spending rate of $3 million per day, such a system is essential to prevent unwanted and costly surprises.***

Recommendation: ***Change the tracking system for nonconformance reports such that at specific prede-***

termined intervals all reports that are not completely closed are moved to the next higher level of management for visibility. After one year to eighteen months reports will be reviewed by the Executive for Construction and after two years by the CEO of the MTA.

Recommendation: *Consider putting more backing, financial and status, into the inspector certification program to increase the rate of achievement and number of certified inspectors.*

18. Summary

The personnel presently responsible for quality assurance of rail construction for MTA are well-grounded (i.e., in general conformity with U.S. Government quality specifications) in respected quality management techniques and methods. They have the ability to support MTA engineering management in providing a cost-effective, successful, reliable and safe rail system. They are building a competent MTA internal quality management capability. This capability is comprised of quality assurance policies, procedures for implementing those policies, the underlying documentation to implement the procedures, the collection of appropriate data to understand trends and a series of audits to test the application of the policies and procedures. When coupled with the ongoing capability of their construction management contractors and engineering management contractors, this creates an effective quality assurance program. Lines of authority and responsibility are clear. At the present time the balance between internal quality assurance management and contractor-supplied quality assurance management is not optimum since more reliance is placed on external contractors than is desirable. The shift to MTA personnel and restructuring reporting relationships actively addresses this problem. This shift creates a short-term gap in capability from the supporting contractors since most of the new MTA staff were hired from these contractors.

The "Quality Policy" for the Rail Construction Corporation (RCC), the early construction subsidiary of MTA, published in April 1991 and confirmed in the November 1993 revision, provides strong internal quality assurance management. This policy shifts responsibility for control from management contractors to MTA personnel.

MTA has developed a strong quality assurance program. MTA management believes such a system is necessary. But when a project is spending three million dollars per day, quality assurance management must "go the extra mile" to prevent those costly surprises which can "derail" the project. "Going the extra mile" means establishing a tracking system to detect any item which escapes the controls created.

Chart 1

Evolution of Rail Construction Quality Control

Line	Start	Facilities	Quality Issues
Blue (Long Beach)	1986	21 Stations 3 Flyovers (elevated tracks) 22 Miles Yards and Shops	Rail Construction Contractor (RCC) subsidiary of MTA Lacked authority initially to — •Monitor and document nonconformance work, or •Oversee corrective work Metropolitan Transportation Authority Quality Control Program — •Hires QA manager in 1991 •Construction manager (CM) primary responsibilities covers audits/surveillances, source inspection, QC approval, oversight QA inspection and test verification •CM's quality control staff includes: ••QA manager ••Two QA inspectors perform oversight inspection of Contractor Quality Control (CQC) ••CQC followed by Construction Work Plan ••QA supervisor ••Laboratory technician Construction Contractor Responsible for — •Develop/implement QC program •Perform inspection acceptances •Self-audits and testing •Vendor QA *Q/A Responsibility* — *History* Southern California Rail Consultants At source — •Procured systems •Pre-award surveys •Inspection/test •Audits Transit Construction Management On-site — •Construction •Inspection/test •Audits •Audits performed sporadically •Responsibility ambiguous •Construction Manager (CM) lacked quality control authority •Closed loop corrective action ineffective

Line	Start	Facilities	Quality Issues
Green (Norwalk/ El Segundo)	1990	12 Stations 20 Miles 16.5 on I-105 median, 3.5 on elevated guideway 2 Segmental bridges Yards and Shops	Metropolitan Transportation Authority •Starting in 1986 CM maintains QA Program •MTA QA Program starts in 1990, CM responsible for QA/QC Program •QA/QC manager reports to CM, but — •QC inspectors report to resident engineer (RE) CalTrans At I-105 Freeway sites — •Construction quality •Station platforms
Red Segment 1 (Union Station/ Westlake)	1986	5 Stations 4.4 Track Miles 4 Tunnels Yards and Shops	Metropolitan Transportation Authority •Director of Quality starts in 1990, reports to RCC Deputy Executive Officer •CM responsible for developing/implementing QA Program per RCC Quality Program •QA manager reports directly to CM •Audits and surveillances stepped up •QA audit program covers contractors, system manufacturers, systems installation, and testing
Segment 2 (Wilshire Corridor)	1988	4 Stations 6.7 Miles 1 Tunnel	Metropolitan Transportation Authority •CM quality control staff includes: ••QC manager ••Chief QC inspectors for facilities, tunnels and systems •Inspectors report to QC management, independent from residential engineers •Quality Control Inspection Instructions (QCII) developed and implemented •Established sign-off requirements for QCII check sheets •Closed loop reporting system highlights nonconformance conditions that must be resolved before final acceptance
Segment 2 and 3 (Vermont/ Hollywood Corridor)	1988	7 Stations 11.6 Miles 2 Tunnels	Metropolitan Transportation Authority •Director of Quality Management reports directly to the Construction Executive Officer •As of 1994 QA and QC become an in-house function, reporting to the Director of Quality Management •In 1995 takes over quality management with a staff of 17 inspectors •In-depth audits are conducted with Engineering Management Contractor participation
Blue (Union Station/ Pasadena)	1994	14 Stations 13.6 Miles 3 I-110 Freeway Crossings Cut and cover grade separations 1 Aerial guideway 1 Segmental bridge 13 Bridge upgrades Yards and Shops	Metropolitan Transportation Authority •Before start of construction, QA manager takes over responsibility •Established work plan in use •Functions under CM include: audits and surveillances, source inspection, Contractor Work Plan (CWP) approval and oversight verification •Functions of contractor include development/implementation CWP, testing and readiness reviews