



IMPROVING INSPECTIONS OF NYC TRANSIT STATIONS

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OVERVIEW

On August 16, 2009, at 10:18 p.m., a large section of the arched brick ceiling at the 181st Street Station on the IRT **R** Line fell onto the platforms and tracks. Fortunately, no one was injured by the falling bricks and subway service to the station was immediately suspended. New York City Transit (NYC Transit) then temporarily secured the ceiling to protect customers and trains from additional falling debris and reopened the station for subway service on August 31, 2009. NYC Transit budgeted \$16.5 million of its scarce capital funds to clean up the site, run alternate bus service while subway service was disrupted, and provide temporary safety measures that will continue until the ceiling is permanently repaired. To date, \$6.1 million has been expended for these measures.

NYC Transit managers had learned in 1999 that a portion of the ceiling at 181st Street was at risk of collapse. However, it did not begin a comprehensive assessment of the ceiling's condition until June 2009, just two months before the ceiling fell.

The MTA Office of the Inspector General (OIG) examined how the condition at the 181st Street Station went unaddressed for nearly 10 years and what lessons can be learned from this. We also examined two other recent incidents where the failure of a critical station component could have resulted in serious injury or death: the partial collapse of the hung metal ceiling at the Bowling Green Station on the **4/5** Line, and the collapse of a concrete platform panel at the 18th Avenue Station on the **F** Line. Each of the three incidents reviewed during this audit indicates weaknesses in the adequacy of NYC Transit's station inspections. These shortcomings increase the risk of customer injuries and service disruptions. The shortcomings also increase the probability that scarce capital and maintenance dollars will be spent addressing emergency situations. Facing extraordinary pressure to pare spending, NYC Transit simply cannot afford the additional costs associated with emergencies that are clearly preventable.

Station Inspection Program Weaknesses

Weaknesses in NYC Transit's inspection programs were instrumental to the failures discussed in this report:

- During the rehabilitation of the 181st Street Station in 1999-2000, NYC Transit's Department of Capital Program Management (CPM) discovered the distressed ceiling area, and directed the installation of a temporary wooden shield just below it to protect the public from falling bricks. CPM was then responsible for hiring a consultant to inspect the condition of the ceiling bricks, and for obtaining a permanent solution to the

problem. At that time, however, CPM inexplicably failed to pursue a permanent solution, or even hire a consultant to assess the condition of the ceiling.

- Annual inspections conducted by NYC Transit's Department of Subways' Maintenance of Way Division (MOW) subsequent to the 1999-2000 rehabilitation, and an inspection conducted by consultants under contract to CPM in 2007, failed to question the presence of the temporary wooden shield that had been installed to protect the public from falling bricks. The shield's presence should have prompted inspectors to perform an up-close inspection of the area above the shield.
- MOW and CPM conduct their visual inspections of transit stations from the platform or from the tracks. From these vantage points, no inspection could have adequately detected the extent of the ceiling's distress at the 181st Street Station.
- Some critical station components, specifically concrete platforms at elevated stations and ceilings with hung metal panels, are not subject to structural inspection by any unit of NYC Transit. As a result, the risk of component failure is unacceptably high.
- There is no communication between MOW inspectors and CPM's station consultants who perform major system-wide reviews of NYC Transit's stations. As a result of this lack of communication, compounded by the weaknesses in station inspections noted above, NYC Transit's capital program for stations is likely to omit critical projects.

Risk Assessment Weaknesses

An inspection of the 181st Street Station ceiling conducted by MOW in September 2006, which was prompted by concerns that the wooden shield may cause a smoke hazard in case of fire, rediscovered the ceiling problem. Yet, design work needed to begin addressing the problem did not begin until 2009. During this three-year period, MOW and CPM engineers concluded that the ceiling was not in imminent danger of collapse. Based on their assessments, MOW and CPM sought funding for the ceiling repair as a standard capital project, which meant that the project underwent a lengthy planning process that took years to complete. However, it is now clear that the professional judgments regarding the ceiling's stability were inaccurate.

Our review found that neither MOW nor CPM established regular inspections of the site to monitor the ceiling's rate of deterioration. Had data been collected at regular intervals and reviewed by MOW and CPM engineers, their conclusions about the actual conditions of the ceiling could have been better informed. Also, given the elaborate and architecturally rare nature of the ceiling, MOW and CPM may not have had the expertise needed to properly assess the risk of collapse.

Summary of Recommendations

The incidents discussed in this report could have been averted. So that such events do not recur, we recommend that NYC Transit:


- Conduct station inspections that are more thorough and that better coordinate the transmission of information between MOW and CPM;
- Develop a list of hard-to-reach and unique station components that require periodic up-close inspection, as well as the procedures to perform such inspections;
- Require inspections of platforms and other concrete structures on elevated stations on a regular basis;
- Inspect hung metal ceilings and the station ceilings from which they are suspended on a regular basis; and
- Scrutinize the risk assessments of the 181st Street Station ceiling that were conducted between the rediscovery of the problem in 2006 and the ceiling collapse in 2009, so as to evaluate what lessons can be learned from this experience.

Summary of Agency Response

We discussed our findings and recommendations with key MOW and CPM officials throughout the audit. They agreed with our recommendations, and indicated that NYC Transit has recently taken steps to improve its structural inspections of transit stations.

Shortly after the 181st Street ceiling collapse, NYC Transit established an inspection task force to review the inspection protocols pertaining to the structural condition of stations.

MOW has agreed that the ceiling condition at the 181st Street Station should have been identified by its annual inspections. MOW officials have since issued verbal instructions to inspectors regarding obstructions. Specifically, inspectors are to note in their reports when an area to be inspected is not visible because of an obstruction such as the wooden shield installed at the 181st Street Station, so that a more thorough up-close inspection can be performed at a later date. While we commend this action, we recommend that MOW write this directive into its inspection guidelines. We also discussed the matter with CPM, and it has agreed to change its inspection manual to this effect.

In another step designed to better guide the inspection process, the newly established inspection task force has begun to compile a list of hard-to-reach and unique station components that will be subject to regular up-close inspections by MOW. MOW indicated that the ceiling at the 181st Street Station and the similarly designed ceiling at the 168th Street Station on the  Line have been added to the list.

MOW and CPM have also agreed that better communication among the inspection groups would ensure more accurate inspections and better prioritization of capital expenditures on stations. To this end, CPM will change its inspection guidelines to ensure that its station consultants obtain the results of MOW's inspections.

The inspection task force is also considering how to revise its protocols to include the inspection of concrete components on elevated structures, as well as structural ceilings behind hung metal panels. At this point, which NYC Transit unit will inspect the support structures for the hung metal panels is undetermined. However NYC Transit agreed to our recommendation on this issue.

In order to improve capital project planning, MOW and CPM have agreed to examine the assessments of the 181st Street Station ceiling conducted between 2006 and 2009, to see what lessons can be learned from them. The OIG will continue to monitor these efforts.

Finally, NYC Transit informed us that its inspection task force under the direction of Thomas Prendergast, the new president of NYC Transit, meets regularly to review inspection protocols, and has expanded its focus to include specialized structures such as truss bridges, and underwater structures, as well as, transit stations. We are pleased by NYC Transit's response to our concerns regarding station inspections, and by the more expansive review that the inspection task force is pursuing regarding other NYC Transit structures.

BACKGROUND

Responsibility for the structural integrity of NYC Transit's 468 stations¹ resides within MOW and CPM. Their respective station inspection programs are designed to provide crucial information in support of maintenance, repair, and capital construction activities.

Maintenance of Way

The Structural Inspections Section of MOW's Division of Engineering is responsible for annually inspecting the structural condition of NYC Transit stations, with the exception of viaducts. Guided by MOW's *Structural Inspection Policy Instructions*, the Structural Inspections Section uses a rating system to prioritize structural deficiencies found at stations. The rating system has been established to indicate whether a defect needs repair within 30 days or may be addressed as part of an annual maintenance program. The annual inspections concentrate on steel and structural concrete at all underground stations, and structural steel at all elevated stations.

MOW's Line Structure Engineering Section, also known as the "on-call" section, is responsible for providing engineering services, which includes inspections and risk assessments of specific station components, in response to service requests made by NYC Transit's Station Maintenance & Support subdivision (Station Maintenance).²

Capital Program Management

Historically, NYC Transit has relied on its capital program to rehabilitate deteriorated transit stations. However, because of delays in the station rehabilitation program, escalating rehabilitation costs, and deferral of much rehabilitation to future capital programs, NYC Transit has recently decided upon a strategy of smaller-scale, component-based programs to address specific station deficiencies on a more frequent cycle. Instead of reconstructing a whole station, NYC Transit will only repair that station's most deteriorated components, for example, its stairs and canopies.

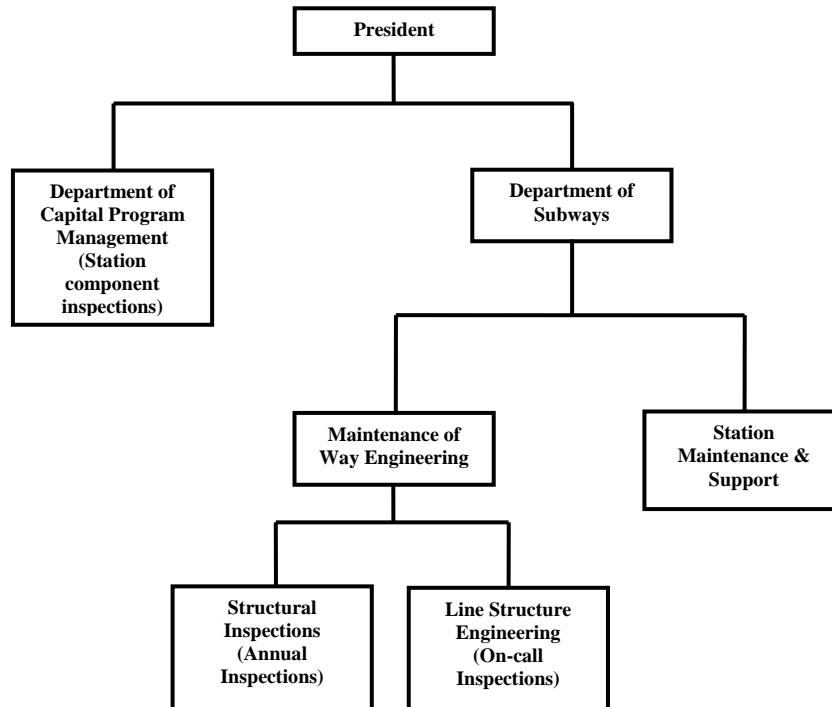
To support this new approach to capital projects, station consultants retained by CPM conducted a survey involving visual inspections of all 468 NYC Transit stations between May 2007 and September 2008. The primary purpose of the survey was to assess the condition of various station components, including stairs, platforms, canopies, vents, walls, and ceilings. The

¹ NYC Transit's 468 stations are classified as follows: 277 subway, 142 elevated, 29 open-cut, 12 viaduct, and 8 embankment.

² Station Maintenance is responsible for masonry, miscellaneous repairs of stations, and inspection of viaducts. It is situated within the Stations Operations Division, which is the custodian of NYC Transit's 468 transit stations. Although supervisors from this division do conduct station inspections, the primary purpose of these inspections is to assess general cleanliness and to detect hazardous conditions that may pose a risk to customers, such as loose handrails, missing floor tiles, and broken steps. These inspections are not part of this report.

consultants rated over 11,000 station components on a five-point scale according to a methodology developed by CPM for the survey and spelled out in its *Station Inspection Manual*. NYC Transit uses the data obtained from this survey to identify and prioritize future capital work, and has plans for another survey in 2013 to update its station condition data.

NYC Transit Structural Inspections and Repairs of Stations Organizational Chart



Structure of This Report

In this report we discuss as case studies three incidents in which critical station components failed: the 181st Street Station ceiling, the partial collapse of the hung metal ceiling at the Bowling Green Station, and the collapse of a platform panel at the 18th Avenue Station on the F Line. Each of these incidents posed a serious danger to customers and workers, and neither MOW's annual inspections nor CPM's station surveys had anticipated such events occurring. In the pages that follow, we identify shortcomings in the adequacy and the extent of MOW and CPM's station inspection programs. We also identify weaknesses in MOW's and CPM's risk assessment of the 181st Street Station. Lastly, we make recommendations to address these deficiencies.

STATION INSPECTIONS NEED TO BE MORE THOROUGH AND BETTER COORDINATED

Case Study 1 – Partial Collapse of Brick Ceiling at 181st Street Station on the **1** Line

On August 16, 2009, a 30-foot by 30-foot section of the brick ceiling at the 181st Street Station on the IRT **1** Line fell onto the tracks and the adjacent platforms. Subway service was immediately suspended, and did not resume until August 31, after NYC Transit had temporarily secured the ceiling to protect customers and trains from any additional falling debris.³ As of May 6, 2010, approximately \$6.1 million had been spent on emergency stabilization and safety measures,⁴ and NYC Transit currently projects a total cost of \$16.5 million to ensure customer safety until the ceiling is permanently repaired.



181st Street Station, Following August 16, 2009 Ceiling Collapse

This case study examines how problems with the ceiling at the 181st Street Station went unaddressed for 10 years, leading eventually to the ceiling's collapse. It illustrates how management lapses, poorly executed inspections, and weaknesses in NYC Transit's inspection

³ During the service outage, shuttle buses replaced train service between the 168th Street and Dyckman Street stations.

⁴ The \$6.1 million expense includes the costs of cleanup and the construction of temporary protective scaffolding to prevent bricks from falling to the platforms and tracks. Also included are the costs of providing station agents on a daily basis to prevent congestion on platforms that have been narrowed by the temporary protective scaffolding.

protocols contributed to this potentially disastrous event. In effect, NYC Transit's poor performance over the 10-year time span transformed what was initially a manageable problem into an emergency.

NYC Transit managers learned that a portion of the ceiling at 181st Street was at risk of collapse when the station received a cosmetic rehabilitation in 1999-2000. The rehabilitation, which was completed by in-house work crews managed by CPM, included minor restoration of the ceiling.

Shortly after that work began in 1999, crews found severe ceiling cracks in the vicinity of the south pedestrian bridge.⁵ A subsequent inspection by a CPM engineer found that the cracks were a serious safety hazard and beyond the repair capabilities of in-house work crews. This engineer directed work crews to install a temporary wooden shield measuring approximately 400 square feet to protect the public from falling debris, while CPM pursued a permanent solution.⁶ Since the ceiling is a rare design and the station is listed on the National Register of Historic Places, the engineer concluded that CPM lacked the required expertise to properly inspect the ceiling. He recommended that CPM hire a conservationist to assess its condition and suggest a work plan.

In October 1999, the CPM Construction Manager in charge of the 181st Street rehabilitation approved the recommendation to hire a conservationist. Yet, this action was not taken, and it is not clear now why CPM failed to pursue a permanent solution at that time. However, CPM officials agree that it subsequently lost track of the need to restore the ceiling at the 181st Street Station.

Subsequent to the 1999 discovery of the ceiling problem at this Station, all annual inspections conducted by MOW's Structural Inspections Section for the next seven years failed to identify the problem in their inspection reports, thereby ensuring that a permanent solution would be delayed indefinitely. Even though MOW's *Structural Inspection Policy Instructions* require an inspector to include all structural and non-structural safety-related defects in an annual inspection report, not even the presence of the temporary wooden shield was noted.

It was not until September 2006, when MOW's on-call unit inspected the ceiling in response to a request from Station Maintenance, that the extent of the ceiling damage again became a concern. It should be noted that the inspection was prompted by worries that the wooden shield may cause a smoke hazard in case of fire, rather than by any fears regarding ceiling integrity.⁷

⁵ The 181st Street Station has two pedestrian bridges. The north pedestrian bridge is in active use, allowing customers to cross between uptown and downtown station platforms. The south pedestrian bridge is only used for emergency evacuations. The ceiling collapse occurred above the south pedestrian bridge.

⁶ The temporary wooden shield was installed by work crews in February 2000.

⁷ In July 2006, during a routine inspection of fire safety conditions at the station, NYC Transit's Office of System Safety identified the wooden shield as a smoke hazard in case of fire and directed Station Maintenance to remove the shield. Station Maintenance requested that MOW's on-call unit determine whether the shield could safely be removed. During the inspection, MOW determined that the shield was made of fire retardant material and, as such, was not a smoke hazard.

During the course of the inspection, the MOW inspector climbed atop the wooden shield and found fallen ceiling bricks there. He also determined that a larger area of the ceiling was deteriorated and in danger of falling onto the wooden shield. He recommended that permanent repair of the ceiling be added to a future CPM contract. The Assistant Chief for MOW's annual and on-call inspectors made telephone and written requests of CPM between September 2006 and June 2007 that the ceiling repairs be included in a then-current capital project (Contract A-36004) to construct scrubber rooms at the 181st Station.⁸ In July 2007, CPM formally rejected the request, because the ceiling repairs would require a conservationist and specialized labor and was beyond the scope of work for the scrubber room contract.

In December 2007, more than a year after the MOW on-call inspector reported the poor condition of the ceiling above the south pedestrian bridge, CPM's station consultant inspected the 181st Street Station. As per the CPM *Station Inspection Manual*, the consultant inspected the ceiling from the station platform. While noting in his inspection report the presence of the wooden shield that obstructed the ceiling, the inspector inexplicably gave the ceiling itself a rating of 3.0, thus indicating that the ceiling was functioning as designed and had only moderate deterioration.⁹ As such, CPM's station consultant did not properly assess the condition of the station's ceiling.

After trying and failing to piggyback the ceiling work on the scrubber room contract, MOW made several requests between July 2007 and March 2008 to have CPM add the 181st Street Station ceiling work to a contract for repairing canopies at five stations on the Broadway-7th Avenue line (C-33126). These attempts also could not be accommodated by CPM.

Then, in April 2008, MOW requested that CPM create a project to repair the ceiling at the 181st Street Station and coordinate the repair with two other CPM projects, in order to take advantage of scheduled track outages already approved for those projects. Two months later, a capital project to repair the ceiling at the 181st Street Station was approved. Over the following months, CPM conducted a project assessment, including a scope of work, and the ceiling project obtained approval in June 2009 to begin design work.¹⁰ At this point, almost 10 years had passed since the ceiling problems were first noted in 1999. Then, two months before design work was to begin, the ceiling fell.

⁸ Scrubber rooms house machines that are used to clean and polish station floors.

⁹ *Condition Assessment Inspection Program for Passenger Stations: Station Inspection Manual*, dated February 2007, sets the following rating standards: A rating of 1.0 indicates that the structure functions as designed, with no apparent deterioration. A rating of 2.0 indicates that the structure functions as designed, with minor deterioration. A rating of 3.0 indicates that the structure functioned as designed, with a moderate level of deterioration. A rating of 4.0 indicates that the structure is partially not functioning as designed and/or a considerable level of damage or deterioration is observed. A rating of 5.0 indicated that the structure does not function as designed and/or the level of deterioration is such that non-function may be imminent.

¹⁰ Design work entails an assessment of the problem, in this case, the condition of the 181st Street Station ceiling, and a proposed solution to the problem.

Station Inspection Weaknesses

Our case study shows that neither MOW's annual structural inspections nor CPM's station component inspection identified the ceiling problem at the station. This was partly caused by MOW and CPM inspection guidelines that only require inspectors to conduct visual inspections from station platforms or tracks. From these vantage points, no inspection could adequately detect the extent of the ceiling's distress at the 181st Street Station. According to the consultant hired by NYC Transit to investigate the conditions that led to the ceiling collapse, up-close inspections should be done periodically in order to properly assess the ceiling's integrity.

The large temporary shield that had been installed in 2000 to prevent bricks from falling to the platforms and tracks almost completely obstructed inspectors' views of the ceiling's problem area and hindered visual inspection. The presence of this shield should have alerted inspectors that a problem existed, and triggered a thorough investigation, including an up-close inspection of the area above the shield. However, none of the inspectors responsible for assessing the condition of the station ever reported the shield or questioned its presence.

We discussed this matter with the former Assistant Chief of MOW Engineering who was responsible for MOW's inspectors between 2005 and 2009. He stated that given resource constraints, annual inspectors have a limited amount of time to conduct inspections, and do not have the time to get a closer look. Furthermore, he added that they would not be expected to perform an up-close inspection. He could offer no explanation why the inspectors failed to even note the presence of the shield in their reports.

CPM echoed MOW in saying that the station consultants were not expected to get an up-close look at the ceiling. However, CPM could not explain why inspectors would rate the condition of the ceiling area that was obscured by the shield.

The thoroughness of a station inspection results, in part, from management's expectations of what constitutes a proper inspection. When inspectors repeatedly fail to even record the presence of a large obstruction in a passenger area, something is seriously wrong with the expectations that govern the inspection process. While not a substitute for common sense, MOW should modify its inspection guidelines to require that its annual inspectors note all obstructed areas so that more thorough inspections can be performed at a later date. CPM should also change its *Station Inspection Manual* to reflect this instruction.

We also find that inspections need to be more comprehensive in scope. One tool that would improve the inspection process, and result in more comprehensive inspections, is a list of hard-to-reach and unique station components that require periodic up-close inspections. MOW managers could use this list to better plan inspections and to guide inspectors in fulfilling their responsibilities. The brick ceiling at 181st Street should be included on the list, as should the ceiling at the 168th Street Station on the same line, which has a similar design.

Our case study also shows that when the CPM station consultants inspected the 181st Street Station in 2007, they had no knowledge of the findings from previous inspections conducted by

MOW. This significant weakness results because CPM does not require that its inspectors review previous MOW inspection reports or communicate with their counterparts in MOW to learn of major defects before inspecting a station. Thus, while the MOW on-call inspector reported the deteriorated ceiling in September 2006 and MOW management was trying to add the repair to the MTA's capital program, CPM's station consultants were completely unaware of MOW's work when they inspected the station the following year. To improve the effectiveness of its component inspection program, CPM should change its inspection manual to require that the most recent annual and on-call inspection reports be obtained from MOW and reviewed by its station consultants prior to inspection. This would help ensure more accurate results, and improve the prioritization of capital expenditures on stations.

We are also troubled that CPM so easily lost track of the need to repair the ceiling after the station was rehabilitated in 1999-2000. That CPM inexplicably failed to pursue a permanent solution, as recommended by one of its own engineers, reflects poor project management. However, we are unable to get to the root of this management failure because the project records are unclear on this issue, and, since the project is 10 years old, managers' recollections are vague. We are therefore unable to recommend a specific solution.¹¹ While this significant project management lapse is disturbing, we note that the weaknesses in station inspections documented previously ensured that no permanent solution would be pursued for at least seven years.

The 181st Street Station Ceiling Problem Was Not Considered Urgent

In examining the response to the rediscovery of the ceiling problem at the 181st Street Station in September 2006, we sought to understand why design work did not begin until 2009, three years after the rediscovery. To do this, we reviewed project documents and interviewed current and former MOW and CPM engineers.

We found that none of the engineers who examined the ceiling prior to its collapse in 2009 judged it to be an urgent problem in need of immediate repair. The MOW on-call inspector who rediscovered the ceiling problem in September 2006 told us that while the ceiling needed repair, in his judgment, it was not in imminent danger of collapsing onto the platforms and tracks. Additionally, the former Assistant Chief of MOW Engineering told us that he believed then that there was sufficient time to assess and repair the ceiling before it became a risk to customers. As a result, following standard procedures, he tried several times between September 2006 and March 2008 to add the ceiling to NYC Transit's capital program.

¹¹ According to NYC Transit documents, which we shared with CPM officials during our audit, CPM had Department of Subways' approval in early 2000 to hire a conservationist and pursue a permanent solution to the problem. As noted earlier, the CPM construction manager in charge of the 181st Street Station rehabilitation in 1999-2000 had approved a CPM engineer's recommendation to hire a conservationist, but no action was taken at that time. We discussed this with CPM's Program Officer for Stations who stated that CPM did not have the funding in place to hire a conservationist, but acknowledged that it was CPM's responsibility to secure the funding. He went on to state that, in his view, a permanent solution was not pursued at least in part because of a miscommunication among CPM officials.

The ceiling work entered CPM's capital planning process in June 2008, and began a deliberate and lengthy assessment that is required of all standard capital work. Known as the Project Master Plan phase, this review includes a preliminary scope of work, budget estimates and a project schedule. The review is designed to produce a well thought out scope of work that is consistent with NYC Transit's priorities.¹²

As part of this review, in October 2008, three CPM engineers examined the ceiling at the 181st Street Station to assess the extent of the damage, and begin preparation of a preliminary scope of work. They too concluded that the ceiling should be repaired, but that it did not require immediate attention. According to the Senior Director for CPM's Stations Program Planning and Management unit, there was not a lot of pressure being exerted to forge ahead quickly in this case. He added that the historic status of the station necessitated additional research to complete the review. In all, the Project Master Plan for the 181st Street ceiling took about 12 months, which the Senior Director said is not unusual.

It is now clear, however, that the ceiling needed to be repaired much sooner than either MOW or CPM had expected. Given that the Station's arched brick ceiling was rare, a follow-up risk assessment performed immediately after the ceiling problem was rediscovered in 2006, by an engineer specializing in brick structures, may well have allowed for a proper assessment of the ceiling's risk of collapse.

While the MOW and CPM engineers involved in the 2006 and 2008 evaluations told us that a specialist in arched brick ceilings would be needed during the project's design phase, none of these engineers thought that it was necessary to have such expertise available to advise them during their respective evaluations. As previously noted, though, the CPM engineer who examined the ceiling in 1999 concluded that CPM needed to hire a conservationist in order to properly assess the ceiling's condition.

The lead engineer of CPM's 2008 review told us that he was unaware of the conclusions reached by the CPM engineer in 1999, and that he never thought to recommend that CPM hire a conservationist to advise him during the 2008 review. While he acknowledged that the advice of a specialist would have been helpful, he observed that it could take three to four months to hire one and that there was little money to do so. In our view, though, appropriate engineering resources needed to be made available on an expedited basis.

CPM currently retains "indefinite quantity consultants"¹³ to advise its engineers during the planning phase when complex concrete, steel, soil, and water-related assessments are involved. However, there are no indefinite quantity consultants for masonry and brick. CPM should consider making such consultants available to its engineers during the project planning phase. It

¹² At which point the work is eligible for project funding, subject to the approval of the MTA Board and the MTA Capital Program Review Board. Once project funding is secured, the design phase can begin.

¹³ An indefinite quantity consultant agrees to furnish an unspecified (but within certain limits) quantity of services during a stated period of time, delivered according to customers' orders.

should also consider whether other specialized consultants are needed. Additionally, CPM and MOW should improve coordination so that CPM's specialty consultants can assist MOW engineers with assessments of unusual structures and conditions.


Further, after the ceiling problem was rediscovered in September 2006, MOW did not establish regular inspections of the site in order to properly monitor the ceiling's rate of deterioration. So, when CPM assessed the site in 2008, it was unable to determine the rate at which the ceiling was deteriorating. CPM also did not establish regular monitoring after it inspected the site in 2008. Had data been collected and reviewed at regular intervals, engineers' conclusions about the condition of the ceiling would have been better informed. MOW and CPM should determine when to establish periodic inspections of troubled sites so as to properly gauge deterioration rates.

In light of the risk that the ceiling's condition posed to its customers and workers, and the additional costs involved in responding to an emergency situation, it is essential that NYC Transit examine the reasons why MOW and CPM's risk assessments of the 181st Street Station ceiling reached conclusions that missed the mark. The examination should be undertaken so as to evaluate what lessons can be learned from this experience.

Preliminary Agency Response to OIG Findings

On August 28, 2009, then NYC Transit President Howard Roberts issued a letter to the Chairperson of the MTA Board's New York City Transit Committee to apprise the Board of the steps taken by the agency in the wake of the partial ceiling collapse at the 181st Street Station. In that letter, Mr. Roberts indicated that he had directed NYC Transit's engineers to review the agency's inspection protocols, so as to "identify those areas where more comprehensive inspections using specialized means and equipment could be employed to spot potentially serious latent defects."

We discussed our findings and recommendations with MOW's Chief Engineering Officer on March 17, 2010. According to this official, NYC Transit has established an inspection task force, which the Chief Engineering Officer chairs jointly with the Deputy Vice President for Engineering Services at CPM. He stated that the task force, now under the direction of Thomas Prendergast, the new president of NYC Transit, meets regularly to expand on existing guidelines for inspections, and is reviewing inspection protocols for all NYC Transit structures. He noted that a draft report of its findings is circulating among task force members.

The Chief Engineering Officer agreed that the ceiling condition at the 181st Street Station should have been identified by MOW's annual inspections. In order to better guide the inspection process in the future, and consistent with OIG's recommendations, he stated that the task force had begun to compile a list of hard-to-reach and unique station components, and that the ceilings at the 181st Street Station and the 168th Street Station on the  Line are included on that list. MOW will now use the list to conduct more comprehensive inspections of NYC Transit's facilities. He also stated that he has issued verbal instructions to his annual inspectors to note when an area is not visible because of an obstruction, so that a more thorough up-close

inspection can be performed at a later date. He agreed that better communication among the inspection groups would also improve the process.

In response to our proposal that MOW and CPM study the risk assessments of the 181st Street ceiling performed in 2006 and 2008, MOW's Chief Engineering Officer agreed, and stated that there should be better initial inspections of unfamiliar structures. He went on to state that MOW could improve its risk assessments by using CPM engineering consultants who specialize in specific fields, as well as through better coordination between MOW and CPM. MOW inspectors should be trained to know when to ask their managers to request CPM assistance in inspecting unfamiliar structures. CPM engineers could then conduct joint inspections with MOW engineers, and, if needed, have CPM consultants join the inspections.

We also discussed our findings and recommendations with CPM's Program Officer for Stations (CPM's Program Officer), who also agreed that there should be more thorough and better coordinated inspections of stations. He stated that CPM would revise its inspection manual to require that its station consultants note when an area is visually obstructed, so that a more thorough up-close inspection can be performed at a later date. He agreed that CPM's inspection manual should be revised to require that station consultants obtain the reports of MOW's most recent annual and on-call inspections, including inspections of hard-to-reach and unique station components, and review these reports prior to CPM inspection. He also agreed that CPM should examine the assessments of the 181st Street Station ceiling conducted between 2006 and 2009, so as to see what lessons can be learned from them. As one part of this review, he agreed to consider expanding the number and specialty types of consultants available for the Project Master Plan phase.

RECOMMENDATIONS

1. MOW and CPM should incorporate into their respective inspection guidelines the requirement that (a) inspectors note when an area is not visible because of an obstruction, and (b) a more thorough up-close inspection of any area so noted be performed shortly thereafter.
2. MOW should develop a list of hard-to-reach and unique station components that require periodic up-close inspection, and develop procedures to perform such inspections.
3. CPM should incorporate into its *Station Inspection Manual* the requirement that its station consultants obtain MOW's most recent annual and on-call inspection reports, including inspection reports on hard-to-reach and unique station components, and review these reports prior to CPM inspection.
4. MOW and CPM should scrutinize the assessments of the 181st Street Station ceiling that were conducted between the rediscovery of the problem in 2006 and the ceiling collapse in 2009, so as to evaluate what lessons can be learned. Considerations should include:
 - a. Establishing procedures for periodic inspections of troubled sites to properly gauge deterioration rates.
 - b. Making masonry, brick and other consultants available to CPM during the project planning phase as needed.
 - c. Improving coordination so that CPM's specialty consultants can assist MOW engineers with assessments of unusual structures and situations.

Final Agency Response:

In its formal response to our draft audit report, NYC Transit agreed with the above recommendations.

SOME CRITICAL STATION COMPONENTS ARE NOT INSPECTED AT ALL

The events leading up to the partial ceiling collapse at the 181st Street Station reveal that critical station components are not being properly inspected. The next two case studies in this report demonstrate that NYC Transit does not inspect the integrity of some critical station components, including ceilings with hung metal panels suspended beneath them, and elevated station platforms. These case studies show that even a partial failure of one of these key components could result in serious injury. Thus, the present risk is unacceptably high.

Case Study 2 – Partial Collapse of Hung Metal Ceiling at Bowling Green Station

For aesthetic purposes, NYC Transit has installed secondary panels that are suspended below a structural ceiling in some stations. These secondary panels are referred to in various ways, including as suspended ceilings and hung ceilings.

On the morning of April 3, 2007, a section of the hung metal ceiling at the Bowling Green Station in Manhattan on the 4/5 Line fell onto the southbound platform. Fortunately, there were no injuries. Consulted by Station Maintenance, MOW's on-call inspector determined that the hung metal ceiling failed because of water leakage, which had corroded its steel support assemblies. The on-call inspector also found other sections of the hung metal ceiling with corroded supports that needed immediate repair. Station Maintenance then replaced the missing ceiling section and repaired the other sections noted by the inspector. In total, Station Maintenance replaced 60 square feet of metal ceiling.

On October 29, 2008, yet another section of the hung metal ceiling fell at the Bowling Green Station. Again, fortunately, no one was injured. Station Maintenance completed repairs on this section of the ceiling on November 20, 2008. However, water leakage continues throughout the station, and, as of our observations on February 17, 2010, at least a dozen sections of the hung metal ceiling are corroded, bent, or missing entirely.



Bowling Green Station with Missing Ceiling Panels, February 17, 2010

Accountability for Ceiling Inspections at Stations with Hung Metal Panels is Lacking

A well-known concern about hung ceilings is that they can mask serious underlying problems. There are three areas where these problems occur: the ceiling panels, the support assemblies that hold the panels, and the structural ceiling that holds the support assemblies and that is masked by the panels. The Senior Director for Line Structure Engineering at MOW Engineering told us that he has argued repeatedly against the installation of hung ceilings in transit stations because they are difficult to inspect.

NYC Transit does not maintain a list of stations that have been outfitted with hung metal ceilings. However, a CPM Design Manager, with about 25 years of experience in transit station design, told us that there are at least nine stations, including Bowling Green, with hung metal ceilings.¹⁴ We reviewed Station Maintenance's records for these stations and found that a portion of the hung metal ceilings at five of the eight other locations had fallen onto the platform one or more times during the last four years. The apparent reason for these failures is ceiling support assemblies that have been weakened by water infiltration.

¹⁴ According to this CPM Design Manager, the following stations have hung metal ceilings that were installed as part of station construction or modernization between 1970 and 2000: Lexington Avenue-63rd Street, Roosevelt Island, 21st Street-Queensbridge, Jamaica-Van Wyck, Sutphin Boulevard, Parsons Boulevard, Bowling Green, Herald Square (IND Platforms) and Herald Square (BMT Platforms).

Neither MOW's annual inspectors nor CPM's station consultants are required to inspect the structural ceiling behind hung metal panels. Nor are they required to inspect the panels or the support structures of those panels. As a result, both inspections fail to accurately assess the condition of ceilings in any station that contains hung metal panels.

For example, CPM's station component inspection of the Bowling Green Station was conducted in September 2007. Its report noted that water was leaking from the ceiling above the southbound platform and that some metal ceiling panels were missing. Yet, the ceiling above the southbound platform was given a rating of 2.5, thus indicating that the structure functioned as designed and that the particular component examined had minor to moderate deterioration. Because of the lack of coordination between CPM and MOW inspectors, the CPM station consultant was unaware of the ceiling failure that had occurred just five months before his inspection. Furthermore, one year after CPM's component inspection, a portion of the hung metal ceiling fell again.

It is clear that fixing responsibility for inspecting the structure behind hung ceilings and generally making inspections more thorough and better coordinated, are among the measures needed to ensure the integrity of ceilings with hung metal panels. Improved inspections would also produce better information for capital planning purposes.

Preliminary Agency Response to OIG Findings

According to MOW's Chief Engineering Officer, the inspection task force is considering whether MOW should add the structural ceilings behind hung metal panels at Bowling Green and other stations to its list of hard-to-reach and unique station components, and assign these inspections to MOW. This step would ensure that these structures are regularly inspected. However, he did not agree with our assessment that hung metal ceilings themselves should be included in the list of hard-to-reach and unique station components. In his view, a hung ceiling is an architectural, not structural, component that should be inspected by Station Maintenance.

To the contrary, when we addressed this issue with a former Station Maintenance General Superintendent, who is currently a Deputy Line Group Manager, he indicated that up-close inspections of hung ceilings and the areas behind such ceilings should be performed by MOW.

Obviously, NYC Transit must promptly assign responsibility for the inspection of these ceilings. It is simply unacceptable for inspections to remain in limbo while each of two units denies responsibility for conducting them, thereby putting the safety of customers at risk.

Further, we discussed with CPM's Program Officer our recommendation that MOW or Station Maintenance inspect hung metal ceilings, their support assemblies, and masked structural ceilings. He agreed that CPM's inspection manual should be revised to require that its station consultants obtain the most recent reports of such inspections and review them prior to conducting their own station inspections.

RECOMMENDATIONS

5. NYC Transit should identify all ceilings containing hung metal panels. All such ceilings should then be included in the list of hard-to-reach and unique station components. The structural ceilings and the panel support assemblies should also be included in that list.
6. NYC Transit should assign responsibility for inspections of ceilings with hung metal panels. Such inspections should include not only the panels, but also up-close inspections of the structural ceiling and the metal support assemblies that underlie the hung panels.
7. CPM should revise its inspection manual to require that station consultants obtain the reports from MOW's inspections of hung metal ceilings and review these reports prior to their own station inspections.

Final Agency Response:

In its formal response to our draft audit report, NYC Transit agreed with the above recommendations.

Case Study 3 – Collapse of Platform Panel at 18th Avenue Station on the **F** Line

At approximately 2:21 a.m. on May 12, 2009, an 8-foot by 4-foot precast concrete section broke loose from the platform of a NYC Transit elevated station and crashed 25 feet to the street below. The incident took place on the southbound platform at the 18th Avenue Station of the **F** Line. Fortunately, no one was injured and no vehicles beneath the platform were damaged. MOW concluded that an adjacent concrete panel of the same size was also in danger of collapse; its removal of this second panel left an 8-foot by 8-foot hole in the platform.



Collapsed Section of 18th Avenue Station Platform, May 12, 2009

MOW determined that the collapse was due to a failure of the platform panel's concrete support structure. Upon further investigation, MOW concluded that the supporting structures of the station platforms, dating from the 1960s, had been poorly designed. In order to ensure that future failure of a support element would not cause additional platform panels to fall, MOW added steel supports directly below the panels along the length of the station's two platforms.

Following the 18th Avenue Station collapse, MOW and Station Maintenance immediately undertook emergency inspections of all elevated stations in the Subway system. It found that only the Court House Square Station on the **7** Line had the same poor design. To ensure the safety of this station's platforms, MOW added wooden supports directly below the platforms. Wood was used instead of steel because the Court House Square Station is scheduled to undergo rehabilitation in the near future as part of the MTA Capital Program, with that work including complete replacement of the platforms.



Looking Down at the Street through Platform Hole at the 18th Avenue Station, May 12, 2009

Elevated Station Platforms Not Inspected

NYC Transit has 142 elevated stations and each station has one or more concrete platforms. As set forth in MOW's *Structural Inspection Policy Instructions* and confirmed by its Chief Engineering Officer, MOW's annual inspectors examine the steel components of elevated stations, but do not examine their concrete components.¹⁵ According to the former Director of MOW's annual inspection section, the unit has traditionally viewed elevated concrete station elements as being non-structural.

We also found that while CPM examines elevated station platforms as part of its review, CPM's *Station Inspection Manual* does not require up-close inspections of platform undersides – an important part of assessing risk for such components. Hence, the June 2007 CPM station component inspection of the 18th Avenue Station did not include an up-close look at the underside of the platforms and did not note any deterioration in the concrete support structure.

According to CPM's Program Officer, the vast majority of the elevated station platforms are better designed than the platform at the 18th Avenue Station. However, he does acknowledge

¹⁵ For underground portions of the Subway system, as noted earlier in the report, MOW examines both steel and concrete structures.

that it is possible for any platform panel to fail, and fall to the street below. In our view, therefore, a more comprehensive inspection of elevated stations is necessary. MOW should inspect the concrete components of elevated stations on an annual basis. CPM should also ensure that its station consultants obtain the information generated from MOW's more comprehensive inspection of elevated stations, so as to better identify and prioritize future capital work.

Preliminary Agency Response to OIG Findings

According to MOW's Chief Engineering Officer, the inspection task force is considering whether MOW should change its protocols to include the inspection of concrete components on elevated structures. He stated that a more comprehensive approach to elevated station inspections should be initiated as a pilot project so that its results could then be assessed. He went on to state that a more comprehensive inspection could include visual examination of elevated structures from street level, perhaps with binoculars. This would allow inspectors to screen for concrete platform components evidencing a level of deterioration that would then call for up-close inspection with the aid of a lift truck.

CPM's Program Officer agreed its inspection manual should be revised to require that its station consultants obtain the reports of MOW's most recent inspections of elevated platforms, and review these reports prior to their own inspections.

MOW's Chief Engineering Officer insisted that the safety hazard was low for the vast majority of elevated concrete platforms, which are better designed. He said that in these cases, if a platform panel or the supports immediately underneath it failed, the panel would only drop a short distance to the metal beams below and would not plummet to street level. This opinion stands in contrast to that of CPM's Program Officer, who considered it possible for a failed panel even in one of these better designed platforms to fall to street level. In any case, we remain concerned. Any concrete panel with the potential to drop below platform level poses a serious safety hazard.

RECOMMENDATIONS


8. The undersides of all elevated station platforms should be included in the list of hard-to-reach and unique station components.
9. MOW should require and perform annual inspections of platforms and other concrete structures of elevated stations.
10. CPM's inspection manual should be revised to require that its station consultants obtain the reports of MOW's most recent inspections of elevated platforms, and review these reports prior to their own inspections.

Final Agency Response:

In its formal response to our draft audit report, NYC Transit agreed with the above recommendations.

CONCLUSION

In 1999, NYC Transit managers learned that the ceiling of the 181st Street Station was at risk of collapse. Nevertheless, that precarious condition remained largely unaddressed for nearly 10 years. This case study illustrates how management lapses, poorly executed inspections, poor communication and the incorrect assessment of risk can transform a manageable problem into an emergency situation. NYC Transit is extremely fortunate that no one was injured when the ceiling collapsed. Nevertheless, preventable emergencies like the 181st Street Station example present an unacceptable risk to the riding public. Moreover, in these times of fiscal constraint, NYC Transit simply cannot afford the additional costs associated with emergencies like this. Millions of dollars that the agency budgeted in response to this crisis are resources that will now be unavailable to address other critical needs in the Transit system.

This report examined the ceiling collapse at the 181st Street Station, and two other recent incidents at NYC Transit stations: the partial collapse of the hung metal ceiling at the Bowling Green Station, and the collapse of a platform panel at the 18th Avenue Station on the  Line. All three cases reveal systemic weaknesses in the adequacy of NYC Transit's station inspection programs.

Among the weaknesses found through our studies are: confusion of responsibility for conducting inspections; inadequate communication among inspectors; omission of structural inspections for elevated station platforms and ceilings masked by hung panels; absence of up-close inspections of critical station components such as high ceilings; and inspectors' inattention to a large obstruction whose presence signaled that an underlying problem needed to be addressed.

NYC Transit has begun, and must continue, to address these weaknesses, which jeopardize safety, increase service disruptions and waste resources allocated for necessary construction and maintenance, all to the detriment of the riding public.


APPENDIX A: OBJECTIVES, SCOPE, AND METHODOLOGY

Our overall objectives were to determine whether NYC Transit is:

- Adequately conducting structural inspections of its stations;
- Properly coordinating station inspections; and
- Performing structural inspections of all stations and station components on a frequent, regular basis.

To accomplish our objectives, we reviewed applicable NYC Transit manuals, guidelines, policies, and procedures. To develop a detailed understanding of the processes and controls in the inspection system, we met with officials from the agency's Station Maintenance, Capital Program Management, Maintenance of Way, System Safety, and Capital Planning and Budget Departments.

We reviewed 32 of the 468 reports issued by the CPM station component inspection program between 2007 and 2008, with a focus on reports related to our case studies. In regard to the 181st Street Station, we also reviewed the MOW inspection reports from 2004 to 2009, the CPM project files for the 1999-2000 capital work at the station, and the 1994 CPM station inspection report. We analyzed Station Maintenance's repair records for select stations and reviewed numerous reports and e-mails produced by NYC Transit regarding our case studies. Finally, as part of our audit, we visited 10 stations, accompanied by an OIG consultant engineer.

The audit covered NYC Transit's structural inspection programs for stations. It also covered inspections and repairs related to the case studies of the 181st Street Station ceiling from 1994 to 2009, the Bowling Green Station ceiling from 2005 to 2009, and the 18th Avenue Station on the  Line from 2007 to 2009.