New York City Transit

NYCT CBTC Program

Request for Information
For
CBTC Follower Contractors

04RFIN10

Version 1.0

February 5, 2004

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Request for Information for CBTC Follower Contracts

1. INTRODUCTION

1.1. General Background

New York City Transit (NYCT) has embarked on a program to implement Communications Based Train Control (CBTC) on a number of its operating lines. In 1997, NYCT released a Request for Proposal for implementation of CBTC on the Canarsie (L) Line. This initial CBTC program was conducted in three phases. From the proposals received and evaluated, NYCT selected three companies to participate in Phase I, which was a demonstration of CBTC functionality on a test track at NYCT. Based on an evaluation of the results of these Phase I tests, commercial negotiations, and revised proposals, NYCT selected Siemens Transportation Systems (formerly Matra Transport International) as the Leader Contractor. Alcatel Transport Automation and ALSTOM Signaling were selected as Follower Contractors. As the Leader Contractor, Siemens is implementing its CBTC system on the Canarsie Line (Phase II), and has produced Interoperability Interface Specifications, which describe the functionality, and interfaces for the subsystems, which comprise the CBTC system. In Phase III of the Canarsie Line CBTC program, the Follower Contractors were required to modify their systems to be interoperable with the Siemens CBTC system, and to demonstrate conformance to the Interoperability Interface Specifications through simulation and field tests.

At this time, Alcatel is the only Follower contractor who is proceeding with the Phase III demonstration of interoperability of its CBTC subsystems with those of Siemens. NYCT desires to identify one or more suppliers who have the capability to modify an existing communications based train control system or subsystem to satisfy NYCT CBTC functional requirements and be interoperable with the CBTC systems which comply with the CBTC Interoperability Interface Specifications.

1.2. Purpose of This Request for Information

The purpose of this RFI is to solicit interest by potential suppliers of CBTC systems or subsystems, and to obtain feedback on the direction of the NYCT CBTC program. Suppliers interested in future participation as a supplier in the NYCT CBTC program should provide the information defined in Section 3 of this document. A response to this RFI is not required for consideration as a supplier to NYCT for CBTC systems or subsystems in the future. However, further technical discussions will be held with those firms who respond and demonstrate that they have a viable CBTC technology base.

The long-term strategy for qualifying additional suppliers of CBTC systems or subsystems is not fully identified at this time. NYCT intends to use the information obtained as a result of this RFI to assist in the formulation of that strategy.

1.3. Interoperability Forum

NYCT will hold an Interoperability Forum on **March 10, 2004, 10:00 AM, 2 Broadway, New York, New York 10004, Second Floor, CR D2.10 A/B** to discuss this RFI and the expected

response. Attendance at this meeting is not mandatory to respond to this RFI or to be considered for receipt of any future RFP related to the interoperability demonstration program described herein.

Please email, by March 8, 2004, a list of planned attendees to:

Mr. Gregory Perillo (GRPERIL@NYCT.COM)

1.4. Oral Presentations

If companies are invited to participate in oral presentations or technical discussions, NYCT will provide written instructions on the date, time, and information to be addressed during these discussions.

1.5. Receipt of CBTC Interoperability Interface Specifications

At a later date, NYCT will distribute copies of the latest approved CBTC Interoperability Interface Specifications to those firms invited for further discussions. Receipt of these documents will require execution of a Non-Disclosure Agreement.

1.6. Submission of Questions and Responses

Contractors shall submit any questions to **Mr. Gregory Perillo,**

Formal responses (hard copy) shall be sent, **by 2PM March 31, 2004,** to:

Name:	**Gregory Perillo**
Title:	**Procurement Manager, Procurement**
Address:	**New York City Transit**
	130 Livingston Street, 6th Floor, Room 6030D
	Brooklyn, New York 11201
Phone Number:	**718-694-4083**

Electronic copies of the formal responses shall be sent, by 2PM March 31, 2004 (via email), to:

Mr. Gregory Perillo: GRPERIL@NYCT.COM

2. OVERVIEW OF NYCT CBTC PROGRAM

2.1. Canarsie CBTC System

Siemens Transportation Systems (STS) is currently installing a CBTC system along the complete Canarsie Line. The functional, performance, and interface characteristics of this system are described in the CBTC Interoperability Interface. The Canarsie CBTC system is scheduled for initial operations at the end of 2004. The CBTC Interoperability Interface Specifications are based on the Siemens system design.

2.2. Goals of the NYCT CBTC Program

The NYCT CBTC program is designed to provide a state-of-the-art CBTC system that will provide reliable service with improved headway over conventional signal systems. Many operating lines on NYCT interconnect, and operation of two or more lines on common tracks, service diversions, and other operating requirements lead to a requirement that CBTC systems are interoperable. NYCT desires to have multiple sources of CBTC systems in order to sustain competition, ensure favorable pricing, and ensure long-term supply of CBTC systems and subsystems. The CBTC Interoperability Interface Specifications provide the basis to achieve these goals, and allow CBTC subsystems to be procured from different suppliers. For future lines to be equipped with CBTC, wayside CBTC subsystems and carborne CBTC subsystems may be procured from different suppliers.

2.3. CBTC Interoperability Test Program

Phase III of the Canarsie Line CBTC program is currently underway. During Phase III, Siemens has been developing the Interoperability Interface Specifications. The final version of these specifications is due for delivery in April 2004, with a period following for final changes in response to NYCT and Alcatel comments. Phase III interoperability simulation tests are currently scheduled for the fourth quarter of 2004, and field interoperability tests are scheduled for the fourth quarter of 2005.

A Phase III Test Working Group is identifying specific simulation and field tests to be conducted. Siemens is preparing an Interoperability Test Plan, which will form the basis for determining interoperability of Follower systems. Followers will develop specific factory, simulation, and field test procedures based on the Interoperability Test Plan.

The Interoperability Interface Specifications will be validated as a result of the Canarsie Line Phase III simulation and field tests.

2.4. CBTC Interoperability Subsystems and Interfaces

The CBTC Interoperability Interface Specifications provide the necessary information to characterize the CBTC system architecture, functions and functional allocation to subsystems, performance requirements, and information flows across interoperability interfaces.

The primary subsystems from an interoperability perspective are:

a. Wayside Zone Controller;

b. Auxiliary Wayside System (AWS);
c. Carborne Subsystem;
d. Radio Air Gap; and
e. Transponder Air Gap.

Standardization of the interfaces between these subsystems provides the basis for operating a train equipped by one supplier over wayside territory equipped by another supplier. Specifications for interfaces between the wayside systems and the control center (Automatic Train Supervision, or ATS), and between coupled car units which make up a train, provide the data for providing complete system definition to achieve multiple-supplier CBTC interoperability. Attachment A identifies the interfaces for which interface data is currently provided in the CBTC Interoperability Interface Specifications.

2.5. Auxiliary Wayside System

The NYCT CBTC system includes an underlying signal system in addition to the data link for train control, referred to as the Auxiliary Wayside System (AWS). This signal system uses track circuits for interlocking protection, and for long blocks between interlockings. Only home signals and approach signals are used.

2.6. CBTC Interoperability Interface Specifications

The Interoperability Interface Specifications currently consist of the following documents:

a. System Functional Specification
b. System Design Document
c. I2S General Presentation
d. I2S Carborne-Wayside
e. I2S Inter-Carborne Controller
f. I2S Wayside-Wayside
g. I2S Radio Air Gap
h. I2S Transponder Air Gap
i. I2S Safety Principles
j. I2S Software Database
k. I2S System Database
l. System Internal Interfaces Specification, AWS/ZC
m. Train Operator Display Man-Machine Interface Functional Specification

The Radio Air Gap specification may change to the fact that activities are underway to identify a different (dedicated) frequency band of operation for CBTC for future CBTC lines, and the impact on other characteristics of the data communications system is unknown at this time.

2.7. NYCT Desire for Multiple Suppliers

NYCT desires to have a number of qualified suppliers to provide competition on future CBTC procurements. Qualification of these suppliers will take place through the existing Canarsie Phase III program, and future CBTC interoperability demonstration programs, as well as demonstration that potential CBTC suppliers can satisfy NYCT requirements related to design process, safety verification, and system documentation. Attachment B presents a

draft Scope of Work for an Interoperability Demonstration Program involving participation by any new Follower contractors. The costs for the program described in Attachment B would be shared between NYCT and the Follower under a Grant arrangement.

2.8. Potential for Growth in CBTC Functions and Operational Complexity

It is anticipated that definition of new CBTC functions will be added to the Interoperability Interface Specifications as the need for new functions is determined, and as requirements are identified due to operational requirements for more complex operations. The Canarsie Line requires limited interoperability with trains from other lines. However, as CBTC is expanded to other lines, the operational requirements will likely be more complex, and interoperability of CBTC systems from different lines will be essential to daily operation. As a result, it is likely that the CBTC Interoperability Interface Specifications will be periodically updated. It will also be critical that system configuration management is maintained to ensure continued interoperability of systems procured for different lines and from different suppliers.

2.9. Planned NYCT CBTC Procurements

NYCT intends to install CBTC on a number of lines over the next 16 years. Table 2.9-1 presents current projections for CBTC installations.

Line	Number of Stations	Miles
Flushing	21	28
Culver	16	13
Crosstown	16	14
Queens I	8	28
Queens II	15	27
Fulton	24	46
6th Avenue	11	22
8th Avenue	8	19
Broadway	25	25
Dekalb	1	3
Rockaway	14	27

2.10. Flushing Line CBTC Program

The next planned CBTC procurement is for the Flushing Line. Based on successful completion of the Canarsie Line CBTC contracts, Siemens and Alcatel will be qualified to bid as Flushing Line CBTC suppliers. The purpose of this RFI is to identify potential additional CBTC suppliers for post Flushing Line CBTC procurements. As part of the Flushing Line CBTC procurement program, a separate CBTC Systems Integrator contract may be awarded. If this contract is awarded, the CBTC Systems Integrator will provide technical support to the new Follower Contractor(s).

2.11. Possible Scenarios for Procurement of CBTC Subsystems

For future CBTC procurements, NYCT may procure complete systems from a single supplier, or procure carborne and wayside systems from different suppliers. For large lines or procurements, which may involve complex interlocking areas, wayside systems may be procured from more than one supplier for a given line. Carborne equipment may be included in future car procurements. The potential exists for the CBTC data radio system or the wayside CBTC backbone communications network to be procured separately from other CBTC wayside and carborne equipment. The potential also exists for carborne transponder interrogator units to be included in "CBTC-ready" cars, with the remainder of the carborne CBTC equipment procured from a different supplier in a car procurement contract. The CBTC Interoperability Interface Specifications are intended to provide this procurement flexibility to NYCT, while ensuring train control system interoperability. However, direct interchangeability of equipment from different suppliers is not a goal, only interoperability across the interfaces defined in the specifications.

3. RFI RESPONSE

This section describes the information requested in response to this RFI. This information is requested to identify potential future CBTC system or subsystem suppliers, and to obtain information to assist NYCT in structuring a future RFP for a CBTC Interoperability Demonstration Program based on the Scope of Work in Attachment B. Please limit your response to fifteen (15) pages.

3.1. Overview of Company

Provide an overview of your company and product lines relevant to this RFI.

3.2. Interest in Becoming a CBTC System or Subsystem Supplier

Section 2 of this RFI Document provides an overview of New York City Transit's (NYCT's) Signal Modernization Program to replace its aging fixed block, wayside signals/trip stop signal technology with state-of-the-art communications-based train control (CBTC) technology. NYCT intends to competitively procure interoperable CBTC systems/ subsystems, from pre-qualified signal system suppliers, for a number of lines within the NYCT rail network over the next 20 years.

a. Do you have an interest in working with NYCT, and potentially other signal suppliers, and in investing the necessary time and resources, to become qualified to bid on contracts to supply interoperable CBTC systems/subsystems to NYCT under this Signal Modernization Program? Does the information contained within this RFI Document provide you with a sufficient understanding of the NYCT Signal Modernization Program to determine the steps required to become a qualified supplier? If not, in what areas would additional information be helpful?

b. Would you be interested in supplying complete CBTC systems to NYCT, or only certain CBTC subsystems? If the latter, what CBTC subsystems would you be interested in supplying?

3.3. CBTC Experience

CBTC systems/subsystems supplied to NYCT are intended to provide enhanced safety (through continuous speed supervision and reduced reliance on human factors), greater operational flexibility (with smoother and more predictable operations), increased throughput (through the ability to operate trains at higher average speeds and at shorter headways), improved reliability and availability, and reduced life cycle costs.

a. Do you currently have a service-proven CBTC product?
b. For each example of CBTC system or subsystem supply, provide statistics that indicate the scope of the project (route miles, number of cars, number of interlockings, etc.).
c. Based on your current understanding of NYCT's operational, performance and functional requirements, would this service-proven CBTC product be capable of meeting the NYCT-specific requirements? If not, what would be the extent of any

hardware/software modifications required to comply with the NYCT-specific requirements?

3.4. Interoperability Experience

Given NYCT's network operations (in which trains designated for operations on one line may also be required to operate on other lines within the network), and given the staged introduction of CBTC technology across the network, CBTC systems/subsystems supplied to NYCT must be fully compliant with the NYCT Interoperability Interface Specifications identified in Section 2 of this RFI Document.

a. Based on your current understanding of NYCT's Interoperability Interface Specifications, what would be your estimate of the extent of the hardware/software modifications required to adapt your service-proven CBTC system to be fully complaint with these interface requirements? Provide a roadmap that describes the approach you would take in modifying your CBTC system or subsystem to comply with NYCT requirements and interfaces specified in the Interoperability Interface Specifications.

b. Do you have any experience in providing train control subsystems that were required to be interoperable with subsystems provided by other suppliers? If so, based on this experience, do you have any recommendations as to the design approach that should be followed in developing interoperable subsystems?

c. To what extent, and under what conditions, would you be prepared to take on systems integration and safety certification responsibilities for a complete CBTC system, if different suppliers provided individual CBTC subsystems?

3.5. Proposed Interoperability Demonstration Program

3.5.1. Comments on Planned Interoperability Demonstration Program

a. Provide comments on the draft Scope of Work for the Interoperability Demonstration Program described in Attachment B. Present any proposed modifications to the planned interoperability demonstration program or specific requirements of the Scope of Work, including submittals, system development process, test program, or other aspects of the program. Present an alternative approaches to validating compliance with the NYCT Interoperability Interface Specifications in a timely and cost-effective fashion.

b. Discuss what interoperability, system performance, and safety design attributes can be demonstrated to NYCT in the conduct of the program defined in Attachment B.

c. Address any identified limitations or constraints imposed by the interoperability demonstration program, and present alternatives. Identify any schedule, cost, or technical risks associated with these alternatives.

d. Any other comments on this RFI Document or the NYCT CBTC interoperability program are welcome.

3.5.2. Proposed Schedule for Achieving NYCT Interoperability

Present a proposed timeframe for performing the scope of work outlined in Attachment B. This timeframe should include consideration of activities for system development, submittals, design reviews, participation in interoperability and test planning working groups, simulation tests, and field tests. It is NYCT's intent to complete the process of qualifying additional Follower contractor(s) by the end of 2007; please comment on the risks associated with achieving this goal.

3.5.3. Implementation or Technical Issues

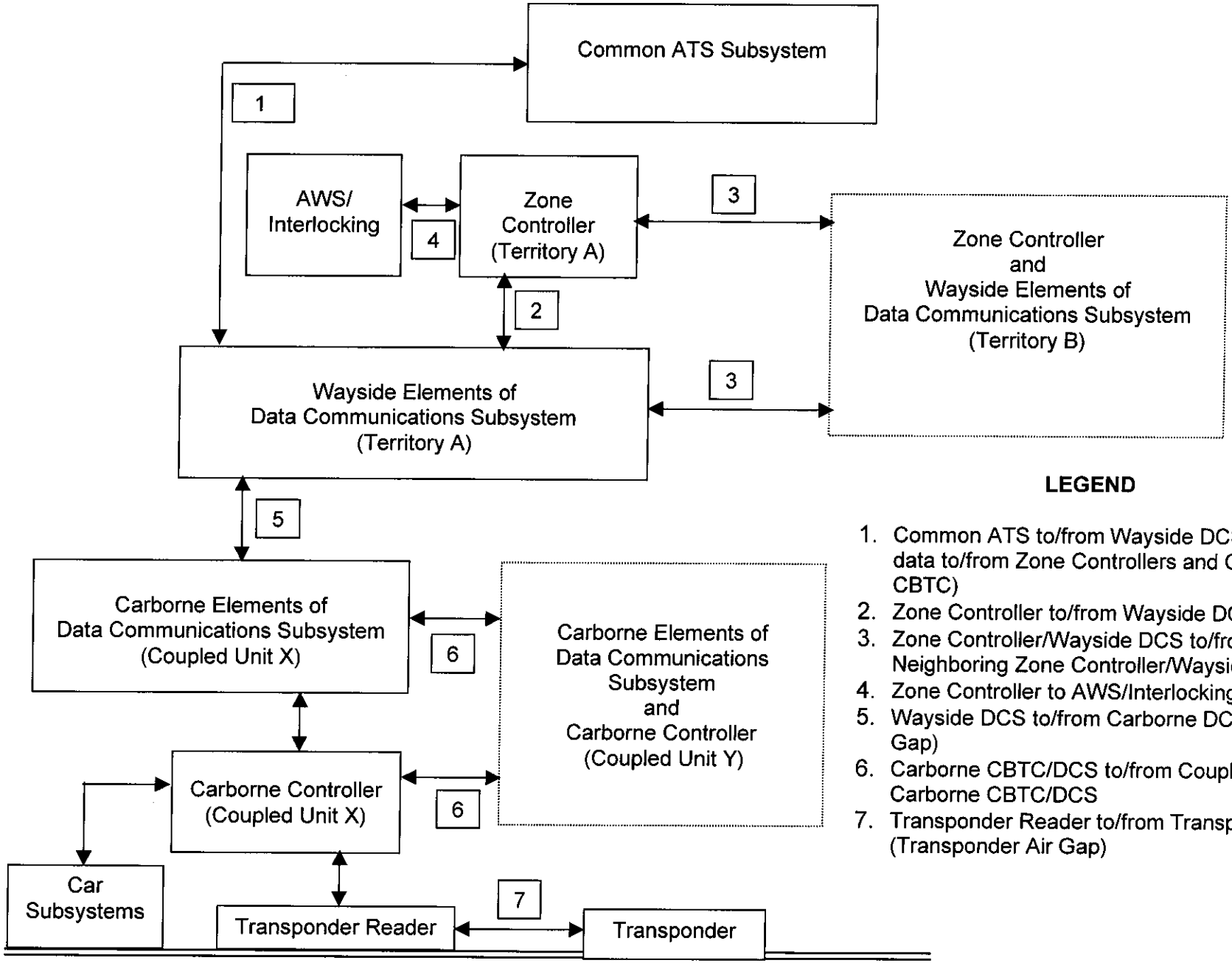
Identify and discuss any implementation or technical issues that you feel represent a risk to the successful demonstration of CBTC interoperability, or to the long-term achievement of CBTC interoperability with multiple lines equipped, multiple suppliers, and operational interoperability of trains operating on different lines.

3.5.4. Interoperability Interface Specifications

The interoperability interfaces for CBTC are documented in the Interoperability Interface Specifications which describe: (1) system architecture; (2) system functionality, by major subsystem; (3) descriptions of how system functions operate; (4) performance requirements; (5) electrical interfaces, where necessary; (6) data flows; (7) message contents and data dictionary; (8) system timing requirements; (9) safety principles. The documents that comprise the Interoperability Interface Specifications are listed in Section 2.6.

a. Is there other data that you feel is necessary to develop an interoperable system?
b. What challenges do you see ahead, or have you experienced in a similar program?

ATTACHMENT A – INTEROPERABILITY INTERFACES



LEGEND

1. Common ATS to/from Wayside DCS (includes data to/from Zone Controllers and Carborne CBTC)
2. Zone Controller to/from Wayside DCS
3. Zone Controller/Wayside DCS to/from Neighboring Zone Controller/Wayside DCS
4. Zone Controller to AWS/Interlocking
5. Wayside DCS to/from Carborne DCS (Radio Air Gap)
6. Carborne CBTC/DCS to/from Coupled Carborne CBTC/DCS
7. Transponder Reader to/from Transponder (Transponder Air Gap)

ATTACHMENT B - DRAFT SOW FOR INTEROPERABILITY DEMONSTRATION PROGRAM

B. Planned Interoperability Program

This section presents a *draft* scope of work and contractual performance requirements for a Follower contractor(s), which may be selected for a future CBTC interoperability demonstration program. Followers may be selected to demonstrate complete CBTC systems or subsystems. Successful completion of this interoperability demonstration program would be a prerequisite for bidding on future CBTC procurements. Respondents to this RFI are invited to comment on this Scope of Work.

B.1 General Scope

B.1.1. Development of Interoperable Subsystems

The Follower Contractor shall develop wayside, carborne and (optionally) CBTC data communication subsystems to achieve interoperability with the Lead Contractor's CBTC subsystems, using the Final NYCT CBTC Interoperability Interface Specifications provided by NYCT (Lead Contractor's approved document).

B.1.2. Participation in Interoperability Working Groups

The Follower Contractor shall participate in Interoperability Interface Working Group, chaired by NYCT, to address technical issues related to interpretation of the CBTC Interoperability Interface Specifications, and to identify any requirements for modifications to these documents.

B.1.3. Participation in Interoperability Test Working Group

The Follower Contractor shall participate in Interoperability Test Working Group, chaired by NYCT. The purpose of this working group is to develop test plans for factory, simulation, and field tests to demonstrate compliance with CBTC functional requirements and interoperability.

B.1.4. Factory Tests

The Follower Contractor shall perform factory tests to demonstrate that their CBTC subsystems satisfy the NYCT CBTC functional requirements.

B.1.5. Interoperability Simulator Tests

The Follower Contractor shall perform interoperability tests on the CBTC system simulator developed by Siemens.

B.1.6. Interoperability Field Tests

The Follower Contractor shall demonstrate the interoperability of its subsystems with the Lead Contractor's subsystems on the designated test track. The tests shall be

conducted in accordance with the test plans being developed for the Canarsie CBTC Phase III program.

B.1.7. System Development and System Documentation

The Follower Contractor shall submit documentation as identified in this Scope-of-Work to demonstrate the suitability of the Follower Contractor's hardware/software CBTC subsystem designs for deployment in the NYCT operating environment.

B.1.8. Development and Maintenance of Program Schedule

The follower Contractor shall prepare, maintain and modify as required, a CPM Schedule Document with sufficient detail, identifying all activities to be performed by the Follower (in accordance with this Scope of Work), including activity durations, program milestones, submittals, and the interdependencies between activities and Contract milestones. The schedule is to be updated monthly, and a narrative description provided monthly describing the reasons for schedule changes from the previous month.

B.2. Development of Interoperable Subsystems

The Follower Contractor shall furnish all labor, materials, tools, and equipment necessary to install and test the CBTC equipment in simulation and on the Authority's designated Test Track.

The Follower Contractor shall ship, receive, unload and store all equipment required for the demonstration test program. The Follower Contractor shall be responsible for the security and protection of his equipment.

The Follower Contractor shall supply the following equipment as a minimum:

a. One Zone Controller.
b. Onboard CBTC equipment required to equip two coupled units. The equipment configuration shall consist of at least one redundant set in order to demonstrate seamless failover. The equipment configuration to be supplied by the Follower Contractor shall include all necessary carborne data communications equipment (either the Lead Contractor's carborne data communications equipment or optionally the Follower Contractor's carborne data communications equipment).
c. Wayside data communications equipment (not required if electing to use Lead Contractor's wayside data communications equipment).
d. Wayside transponders (not required if electing to use Lead Contractor's transponders).
e. Any additional test or support equipment required to verify all of the requirements of the interoperability demonstration test program (e.g., recorders, meters, special test equipment, special tools, simulators, computers, etc.).
f. All cabling and interface equipment required to install the CBTC equipment, including power distribution, required for the interoperability demonstration test program.
g. Any brackets, straps, enclosures, racks, etc. required to properly install the CBTC equipment.

B.3. System Development Process

B.3.1. Design Reviews

The Follower Contractor shall submit Preliminary Design Review (PDR), Critical Design Review (CDR), and Final Design Review (FDR) documents for NYCT review and approval, as detailed below. The purpose of these reviews will be to monitor progress in the design and interoperability process, address Interoperability Interface Specification issues and coordinate support among the Authority, the Lead Contractor and Follower Contractors.

The Follower Contractor shall provide at least twenty (20) days prior notice to NYCT for all design reviews.

The Preliminary, Critical, and Final Design reviews will be held at an Authority facility in New York City. The Authority, at its sole discretion, may elect to hold the review at the Follower Contractor's facility.

The Preliminary, Critical, and Final Design Reviews shall include review of subsystems designs in the following areas:

a. Zone controller subsystem architecture.
b. Zone controller subsystem physical layouts.
c. Zone controller hardware designs.
d. Zone controller software & database designs.
e. Zone controller subsystem interface designs.
f. Carborne CBTC subsystem architecture.
g. Carborne CBTC subsystem physical layouts.
h. Carborne CBTC hardware designs.
i. Carborne CBTC software & database designs.
j. Carborne CBTC subsystem interface designs.
k. Data Communications System design and layout (optional).
l. Safety and Systems Assurance Analyses.

B.3.2. Preliminary Design Review

The purpose of the Preliminary Design Review shall be to ensure the Follower Contractor is starting all interoperability designs properly, to evaluate the progress and technical adequacy of the design approach for the individual subsystems, and its compatibility with the requirements of the preliminary NYCT CBTC Interoperability Interface Specifications. Submittals for the Preliminary Design Review shall include:

a. Subsystem Design Description, in accordance with MIL-STD-498 Data Item Description (DID) DI-IPSC-81432. In addition to the specific requirements of this DID, the document shall include: a comprehensive CBTC subsystem architecture; block diagrams; preliminary design details; subsystem interfaces; subsystem timing, state transition and flow diagrams; communications standards, coding, protocols and security; and details of equipment and products.
b. Software Requirements Specifications for each Software Configuration Item, compliant with MIL-STD-498 (or approved equivalent).

c. A top level software and hardware requirement traceability matrix indicating traceability of all Interoperability Interface Specification requirements to the subsystems being provided.
d. Subsystem Safety Program Plans.

B.3.3. Critical Design Reviews (CDR).

Hardware Critical Design Review (HW-CDR): This review will determine that the detail design of the subsystem under review is consistent with the requirements of the updated preliminary NYCT CBTC Interoperability Interface Specifications. This review will occur approximately 12 months after PDR.

Software Critical Design Review (SW-CDR): This review will determine that the architectural, high-level, software design for each Software Configuration Item is completed. Architectural design for each Software Configuration Item shall be determined and documented in accordance with the Follower's internal corporate process, i.e., all high-level software components shall be defined. As indicated above, the detailed design for each Software Configuration Item shall be documented in accordance with the Follower's internal process. The architectural design shall be compliant with MIL-STD-498 (or approved equivalent). NYCT will audit/evaluate the architectural design data generated for this review.

B.3.4. Final Design Reviews (FDR).

The Hardware Final Design Review (HW-FDR) shall include an update of all of the Hardware, System and Subsystem design activity to date to review compatibility with the final NYCT CBTC Interoperability Interface Specifications.

The Software Final Design Review (SW-FDR) shall determine that the detailed software design (based on the architectural design developed in the previous phase) for each Software Configuration Item is completed. Software detailed design data shall be generated in accordance with the Follower's internal process. The software detailed design shall be compliant with MIL-STD-498 (i.e., all software components/units shall be defined), or equivalent documentation approved by NYCT. As indicated above, the detailed design for each Software Configuration Item shall be documented in accordance with the Follower's internal process. NYCT will audit/evaluate the detailed design data generated for this review. (Note: Software detailed design data need not be contained in formal documentation, e.g. it may be contained in software design tools or in design-tool outputs. In whatever form, the software detailed design must be configuration-controlled.)

In addition to the submittal of updated (final) versions of the PDR and CDR documentation, the FDR submittal shall include the following:
a. Final hardware design documentation;
b. Final software design data for audits/evaluations; and
c. Detailed plans and schedules for the installation and commissioning of the subsystems on the Test Track.

B.3.5. Factory Testing

The Follower Contractor shall conduct factory tests that include testing at the Follower's site. NYCT personnel will witness selected Factory tests. These tests shall include:

a. *Software Configuration Item-Level Testing.* NYCT will evaluate software test procedures and software test results for compliance with the Follower's Verification & Validation Plan and with the Software Requirements Specifications.
b. *Subsystem Qualification Testing.* NYCT will evaluate subsystem test procedures and test results for compliance with the Interoperability Specification and with the Follower's system/subsystem requirements and design.

c. *System Integration and Testing.* NYCT will evaluate system test procedures and test results for compliance with the Interoperability Specification and with the Follower's system/subsystem requirements and design.

B.3.6. Simulation Tests

The Follower Contractor shall perform tests of their CBTC subsystems against a CBTC system simulator developed by Siemens.

B.4. Documentation

B.4.1. Software Plans

The Follower Contractor shall submit for NYCT review and evaluation the software design, development and testing process to be used in the subsystem development process, as detailed below.

The Follower Contractor shall furnish all software for wayside, carborne and (optionally) data communication subsystems as required to support the formal interoperability demonstration test program.

The Follower Contractor shall develop a Phase III Software Development Plan that is compliant with MIL-STD-498 (or approved equivalent). NYCT encourages the reference to internal processes and procedures to fulfill Software Development Plan content requirements. The Plan shall be submitted to NYCT for review and approval. No changes shall be made to the approved Plan without prior NYCT approval. The Software Development Plan shall be subject to audit by NYCT.

The Follower Contractor shall develop procedures for managing the Phase III software configuration in a Phase III Software Configuration Management Plan. This plan shall be compliant with IEEE-828. NYCT encourages the reference to internal processes and procedures to fulfill Software Configuration Management Plan content requirements. The Plan shall be submitted to NYCT for approval.

The Follower Contractor shall document the approach for software verification and validation to be applied in this interoperability demonstration program in a Verification and Validation Plan. This plan shall be compliant with IEEE 1012. NYCT encourages the reference to internal processes and procedures to fulfill Software Verification and Validation Plan content requirements. The Plan shall be submitted to NYCT for

approval. No changes shall be made to the approved Plan without prior NYCT approval. This interoperability demonstration program Verification and Validation Plan shall be subject to audit by the Authority.

The Follower Contractor shall develop and document an approach for performing effective software quality assurance during Phase III. This Plan shall be compliant with IEEE 730. NYCT encourages the reference to internal processes and procedures to fulfill Software Quality Plan content requirements. The Quality Assurance Plan shall be submitted to NYCT for approval. No changes shall be made to the approved Plan without prior NYCT approval. The Quality Assurance Plan shall be subject to audit by the Authority.

The Follower Contractor must demonstrate that the software produced for Phase III was developed in accordance with their corporate processes. This will include evaluations by NYCT of the process artifacts and technical software work products produced for Phase III. The Carnegie Mellon Software Engineering Institute's Software Capability Maturity Model or the Software Capability Model Integration (SW-CMMI) will be used as the model for evaluation of the follower's ability to develop software capable of meeting NYCT standards.

B.4.2. System Safety Documentation

The Follower Contractor shall submit for NYCT review and evaluation the system safety certification process to be used during the Interoperability Demonstration Test Program. The Follower Contractor's safety certification process shall address the safety of the supplied carborne, wayside CBTC and (optionally) data communication subsystems, to demonstrate that each subsystem satisfies the safety requirements of the Interoperability Interface Specifications.

The Follower Contractors will not be required to provide safety certification for the CBTC system as a whole.

The Follower Contractor shall be responsible for the identification, assessment, resolution, and documentation of hazards at the subsystem level. The safety analysis shall be based on U.S. Military Standard MIL-STD-882C, the American Public Transit Association's Manual for the Development of Rail Transit System Safety Program Plans, and IEEE Standard 1483.

The Follower Contractor shall cooperate with the NYCT Independent Safety Assessor in the performance of its work by providing full access for the Independent Safety Assessor to inspect all required Follower Contractor processes, procedures, data and documentation at the Follower's facility.

The Follower Contractor shall submit the following documents as a minimum in support of the Phase III System Safety Program:

a. Subsystem Safety Program Plan that defines the Contractor's specific subsystem safety activities to be adopted during the performance of the Phase III program, consistent with the requirements of the CBTC SSPP. The Subsystem Safety Plan shall be submitted for approval by NYCT prior to the start of work in Phase III and shall be adhered to by the Follower Contractor following this approval. The Subsystem Safety Plan shall provide the following:

i) A description of the safety-critical design processes that the Follower Contractor will follow, and specific safety standards to be employed by the Follower Contractor during Phase III.
ii) A description of the hazard analysis methodologies that the Follower Contractor will employ.
iii) A description of the safety management procedures that the Follower Contractor will adopt throughout the design, installation and test phases.
iv) A description of the Follower Contractor's plans for Safety Verification and Safety Validation, with specific reference to the methods of verification of safety-critical software.

b. Subsystem Safety Assurance Concepts documents that describe the Follower Contractor's application of safety concepts which assure subsystem safety, specifically: fail-safe design (hardware and software) approaches used in the implementation of processor-based safety-critical equipment; operational safeguards; and methods of ensuring safety-critical data integrity. Vital functions identified in the NYCT CBTC Interoperability Interface Specifications must be implemented using concepts, which can be verified as being both correct and sufficiently robust to mitigate the hazards of the subsystem. The Subsystem Safety Assurance Concepts documents shall define the design methodologies upon which the implementation of the interoperability interface requirements will be based, and the safety verification and validation methods consistent with the stated concepts.
c. Subsystem Hazard Analysis and Safety Verification and Validation reports which describes the analysis of the proposed subsystems to determine the effects of safety-critical faults or failures. The subsystem analyses shall analyze the possible hazardous effects of subsystem and component level faults.
d. Final Subsystem Safety Analysis reports which provide a summary of the results of the overall analysis, safety verification, safety validation, and subsystem safety demonstration tests, and demonstrate that all hazards are adequately mitigated.

B.4.3. System Assurance Documentation

The Follower Contractor shall submit Reliability and Availability Calculations to substantiate that the subsystem design will comply with the reliability and availability allocations of the NYCT CBTC Interoperability Interface Specifications. The reliability and availability calculations shall be provided for approval as a preliminary version at the Preliminary Design Review with an update for Critical Design Review and a final version as part of the Final Design Review.

B.4.4. EMC Documentation

The Follower Contractor shall submit an EMC Design Report, which analyzes and reports on EMC design characteristics and emissions applicable to the Interoperability Demonstration Test program, to ensure that test installations will not adversely affect the operation of other systems in the vicinity of the test site.

B.5. System Installation for the Interoperability Demonstration Tests

To support the interoperability demonstrations, NYCT will be responsible for all required trackside installation work on the designated test track. The Follower Contractor shall be

responsible for all required wayside equipment room installation work. NYCT and the Follower Contractor will be jointly responsible for all required carborne installation work.

The Follower Contractor shall submit for NYCT review and approval detailed installation instructions and drawings for all trackside and wayside CBTC equipment.

The Follower Contractor shall submit for NYCT review and approval detailed installation instructions and drawings for all carborne CBTC equipment to be installed on the test vehicles to enable the Authority's Division of Car Equipment to perform the installation with support from the Contractor.

The Follower Contractor shall equip two coupled units.

The CBTC wayside equipment shall provide monitoring of existing wayside signaling equipment, such as switches and track circuits.

The CBTC wayside equipment shall not control any existing wayside signaling equipment. Special test panels shall be used to demonstrate CBTC wayside equipment output logic for displaying the CBTC aspect and associated automatic train stop control, and all other AWS interfaces. The Follower Contractor will not be permitted to control the automatic train stops or switches.

The Follower Contractor shall coordinate the interface to existing wayside equipment with NYCT.

The Follower Contractor shall conduct necessary post-installation checkout tests, prior to the formal interoperability tests, to ensure that the CBTC equipment is installed and functioning properly.

At the conclusion of the interoperability demonstration tests, the Follower Contractor shall remove all equipment and debris from the equipment rooms. NYCT will be responsible for the removal of Follower Contractor's trackside and carborne equipment. All equipment remains the property of the Follower Contractor.

The quality of material, equipment, workmanship and fabrication furnished by the Follower Contractor shall be to an acceptable standard for installation on an operating Railroad. All equipment is to be installed in a secure and robust manner; however, all equipment installations may be considered temporary to provide simple access for testing and to facilitate easy installation and removal. The Follower Contractor shall assure that the work is performed in accordance with the applicable codes, standards, specifications or other special contractual requirements as applicable to installations, which will be viewed as temporary.

B.6. Test Program

B.6.1. Factory Testing

The Follower Contractor shall conduct factory tests to demonstrate all CBTC functions defined in the CBTC Interoperability Interface Specifications. NYCT personnel, or their designee, may witness selected or all factory tests. These tests shall be done in

accordance with a Factory Test Plan approved by NYCT. The Follower Contractor shall build its own simulator or other equipment necessary to demonstrate all CBTC functions. Successful completions of the factory tests will be a prerequisite for proceeding with the simulation tests using the simulator developed by Siemens.

B.6.2. Simulator Testing

Prior to conducting the formal interoperability demonstration tests on the designated Test Track, the Follower Contractor shall conduct simulation tests on the Lead Contractor's simulation facility in France, to verify the interoperability interfaces.

The Follower Contractor shall submit a Simulation Test Plan for NYCT approval at least 60 days prior to the start of the simulation tests.

Simulation tests shall be conducted in accordance with the approved Simulation Test Plan and NYCT reserves the right to witness all or part of the simulation tests.

The Follower Contractor shall submit a Simulation Test Report for NYCT review within 30 days of completion of the simulation tests. Successful completion of the simulation tests will be a prerequisite for proceeding with the formal interoperability demonstrations on the designated Test Track.

B.6.3. Test Track

The test track to be used for the formal interoperability demonstrations has not been determined at this time. The test track may be the Canarsie Line, or a test track area to be determined. NYCT will provide the Follower Contractor with the necessary track layout and CBTC database information.

NYCT will ensure that the Lead Contractor's CBTC equipment under test is compliant with the Final Interoperability Interface Specifications.

The Follower Contractor shall conduct his work in such a manner and at such times and with such precautions and safeguards as the Engineer may require. This shall be for the purpose of both avoiding interference with the safe and continuous operation of the Railroad and avoiding interference with or injury to passengers and employees of the New York City Transit System or other persons. The Follower Contractor's personnel, including supervisory personnel, and those of their subcontractors shall attend or have attended within the past twelve months a current NYCT track safety training course prior to their being allowed on or adjacent to operating tracks. At all times while working on or adjacent to operating tracks, the Follower Contractor, subcontractors, and all of their respective employees shall observe the applicable flagging rules and all other applicable rules, regulations and guidelines of the Authority. They shall follow the instructions of the Flaggers who are responsible for their safety. They shall have in their possession and use as required the necessary personal protective equipment specified by NYCT safety rules and regulations. The Follower Contractor's personnel, including supervisory personnel, subcontractors, and all of their respective employees are <u>never</u> permitted on or adjacent to the operating tracks without flagging protection.

B.6.4. Formal Interoperability Tests

The formal interoperability demonstration test program shall demonstrate, as a minimum, interoperability between:

a. Lead Contractor's zone controller and Follower Contractor's zone controller to achieve seamless hand-off of trains and ability to interface with a common CBTC-ATS system.
b. Lead Contractor's zone controller and Follower Contractor's carborne CBTC equipment using a common data communications subsystem, or, optionally, using the Lead Contractor's wayside data communications subsystem and the Follower Contractor's carborne data communications subsystem.
c. Lead Contractor's carborne CBTC equipment and Follower Contractor's zone controller, using common data communications subsystem, or, optionally using the Lead Contractor's carborne data communications subsystem and the Follower Contractor's wayside data communications subsystem.
d. Lead Contractor's carborne CBTC equipment and Follower Contractor's carborne CBTC equipment (in multi-unit train).

Interoperability demonstrations between equipment supplied by different Follower Contractors are not required (except as detailed in Section B.6.6, below).

The Follower Contractor shall submit a detailed Interoperability Demonstration Test Plan for NYCT approval. The plan shall demonstrate that the Follower Contractor has considered all of the relevant testing requirements contained in the Interoperability Interface Specifications and shall define the range, depth, and other aspects of tests to be conducted.

NYCT will provide an Interoperability Test Plan, developed under the Canarsie CBTC Program Phase III, which all Follower Contractors shall follow.

The Follower Contractor shall submit detailed test procedures to NYCT for approval for each test identified in the NYCT-approved Interoperability Test Plan.

The Follower Contractor shall demonstrate the following capabilities of their modified CBTC subsystems during the Interoperability Demonstration Program:

a. Ability to meet the functional, performance, safety, and interface requirements as contained in the Final Interoperability Interface Specifications.
b. The interoperability demonstration tests shall demonstrate operational functions and the ability to support all operating modes of the carborne and wayside subsystems interfacing with the Lead Contractor's subsystems.
c. The Follower Contractor shall demonstrate ability of CBTC subsystems to provide all safety functions and meet all safety criteria identified in the final Interoperability Interface Specifications. The interaction between Lead and Follower Contractor's equipment, under all circumstances, shall not conflict with the safety requirements. All possible combinations of zone controller, carborne CBTC equipment, and (optionally) data communication subsystem relevant for safe and functional operation shall be tested. Fundamental safety functions to be demonstrated shall include:
    i) Train Location Determination.
    ii) Safe Train Separation Assurance.

iii) Overspeed Protection.
iv) Safe Generation of Movement Authority Through Interlockings.
v) Safe Generation of Movement Authority across zone controller borders.

d. Capabilities related to short headway operation shall be demonstrated by as a minimum as in the following matrix:

Leading Train	Following Train	Zone Controller
Lead Contractor	Follower Contractor	Lead Contractor
Follower Contractor	Lead Contractor	Lead Contractor
Unequipped	Follower Contractor	Lead Contractor
Lead Contractor	Follower Contractor	Follower Contractor
Lead Contractor	Lead Contractor	Follower Contractor
Follower Contractor	Lead Contractor	Follower Contractor
Unequipped	Follower Contractor	Follower Contractor

e. The Follower Contractor shall demonstrate interoperability of carborne equipment with a coupled married pair equipped with the Lead Contractor's carborne system.
f. Capability to communicate and interact among the zone controllers of the Lead Contractor and the Follower Contractor so that safe and seamless train operation is possible across the zone controller boundary shall be demonstrated. The following matrix of zone controller interoperability tests shall be included as a minimum in the overall program:

Zone Controller	Zone Controller	Train
Lead Contractor	Follower Contractor	Lead Contractor
Lead Contractor	Follower Contractor	Follower Contractor

g. Capability of zone controllers and carborne equipment to respond to the Lead Contractor's set of CBTC-ATS commands and to provide responses to CBTC-ATS shall be demonstrated.
h. Appropriate response to induced or simulated failure conditions in terms of fail-safe design covering all possible combinations of the Lead and Follower Contractor subsystems shall be demonstrated.
i. Appropriate responses to induced or simulated failure conditions in terms of transition between operating modes shall be demonstrated.
j. Conformance with or the ability to meet maintainability and diagnostic requirements under interoperable conditions shall be demonstrated.
k. Communication coverage, error handling, cell handoff, blocking train performance, latency, and other parameters determined to characterize the suitability of the Follower Contractor's (optional) communications system for CBTC and non-CBTC applications (passenger announcement/ passenger information triggers and maintenance data, for example) shall be demonstrated under interoperable conditions.

l. Capability of the data link and other system components as required, to support CBTC and non-CBTC applications (passenger announcement/passenger

information triggers and maintenance data, for example) under worst case communications link loading with equipment from various Contractors (as specified in the NYCT CBTC Interoperability Interface Specifications).

m. Ability to update databases and then correctly configure data between equipment from various Contractors (as specified in the NYCT CBTC Interoperability Interface Specifications).
n. Ability of the system to verify proper versions of software or databases, as applicable and defined in the NYCT CBTC Interoperability Interface Specifications.
o. Ability of the system to perform follow ATP profiles shall be tested for safe train separation capability using an interface to the vehicle's emergency brakes, and full ATO mode of operation.

At the Authority's sole discretion, test vehicle 4-car units equipped with Follower Contractor's carborne CBTC equipment may be operated on the Canarsie Line to further demonstrate interoperability with Lead Contractor's wayside CBTC equipment. Similarly, at the Authority's sole discretion, test vehicle 4-car units equipped with the Lead Contractor's carborne CBTC equipment from the Canarsie Line may also be operated on the designated test track to further demonstrate interoperability with the Follower Contractor's wayside CBTC equipment.

The Follower Contractor shall furnish all spare equipment and maintenance facilities required to support its CBTC subsystems for the duration of the Interoperability Demonstration Program.

The Follower Contractor shall provide training for six (6) NYCT Train Operators in the use of the CBTC onboard display and controls, and the required actions to be performed in the execution of each test.

NYCT and the Lead Contractor will manage the demonstration testing, including scheduling and provide a Test Director to manage the day-to-day test activities. NYCT will coordinate track access and train and crew availability.

The Follower Contractor shall prepare and submit certified test results and reports to the Engineer at the completion of each segment of the Interoperability Demonstration Test Program.

B.6.5. Failed Test Resolution

NYCT (with the support of the CBTC System Integrator) will provide technical guidance and support to the Follower Contractor in problem resolution.

In the event that a test fails, the Follower Contractor and NYCT (with the support of the CBTC System Integrator) shall review the test results and analyze the problem. As appropriate, depending upon the results of the problem analysis, either the CBTC System Integrator or the Follower Contractor will make the necessary modifications, and perform the test again.

As success of the interoperability demonstrations is a condition for qualification of the Follower Contractor for future participation in the Authority's procurements of CBTC equipment, NYCT will make every effort to allow a Follower Contractor to repeat failed

tests, within the constraints of the Interoperability Demonstration Test Program schedule.

B.6.6. Informal Interoperability Demonstration Tests

Following successful completion of the formal interoperability demonstration tests (Section B.6.4, above), informal interoperability demonstration tests shall be conducted between wayside and carborne equipment furnished by the Follower Contractor over an approximate one (1) month period.

The scope of the informal interoperability demonstration tests shall be mutually established by NYCT and the Follower Contractor(s), but as a minimum shall include:

a. Operation of Follower Contractor's wayside equipment with Alcatel's carborne equipment.
b. Operation of Alcatel's wayside equipment with the Follower Contractor's carborne equipment.

B.7. Successful Completion of Interoperability Demonstration Program

B.7.1. Qualification for Future CBTC Procurements

Successful completion of the interoperability demonstrations will qualify the Follower Contractor for future participation in the Authority's procurements of CBTC equipment under signal system modernization contracts and new car purchase contracts. (The Follower Contractor is reminded that in future procurements, wayside and carborne CBTC subsystems will likely be procured under separate contracts). Further, the interoperability demonstrations will serve as a technical qualification the Follower Contractor's CBTC equipment subsystems, to the extent that the Authority deems the Follower Contractor's interoperability demonstrations to be successful, and the equipment representative of production equipment.

B.7.2. Evaluation Criteria

Evaluation of the Interoperability Demonstration Program will be based on the following criteria:

a. Results of the Preliminary Design Review (PDR), Critical Design Review (CDR), and Final Design Review (FDR) of the Follower Contractor CBTC subsystem designs, as modified, to comply with the Final NYCT CBTC Interoperability Interface Specifications and be capable of operating within the NYCT operating environment.
b. Results of the simulation and field demonstration tests, which will be considered as pass-fail tests. The Follower Contractor will be evaluated on the demonstrated ability of their CBTC subsystems to meet the performance and functional requirements of the Interoperability Interface Specifications in an interoperable configuration.

B.8. Submittals

B.8.1. Documentation

The Follower Contractor shall submit the following documentation:

a. Preliminary Design Review (PDR) documentation;
b. Critical Design Review (CDR) documentation;
c. Final Design Review (FDR), documentation;
d. Software and Hardware Requirement Traceability Matrix;
e. Software Development Plan;
f. Configuration Management Plan;
g. Verification and Validation Plan;
h. Quality Assurance Plan;
i. Subsystem Safety Program Plan;
j. Subsystem Safety Concepts documents;
k. Subsystem Hazard Analysis reports;
l. Final Subsystem Safety Analysis reports;
m. Reliability/Availability Analyses;
n. EMC Design Report;
o. Trackside and Wayside CBTC Installation Instructions and Drawings;
p. Carborne CBTC Installation Instructions and Drawings;
q. Simulation Test Plan;
r. Simulation Test Report;
s. Interoperability Demonstration Test Plan;
t. Detailed Test Procedures;
u. Certified Test Results and Reports;
v. Schedule Document.

B.8.2. NYCT Review of Submittals

NYCT's goal will be to respond to the Follower Contractor submittals (with status and any comments) within an average of 15 calendar days.

The Follower Contractor submittals to NYCT shall be staggered in order to allow NYCT to accomplish this turnaround.

The use of preliminary or draft documents is encouraged prior to formal submittals in order to improve the quality and minimize comments.