1. INTRODUCTION

The Hudson-Bergen Light Rail (HBLR) is a twenty-one mile, multiple branch light railway currently being deployed in New Jersey’s Hudson River Waterfront communities under a Design, Build, Operate and Maintain (DBOM) contract. New Jersey Transit is the owner with Washington Group and Kinkisharyo forming Twenty First Century Rail Corporation (TFCRC) as the DBOM contractor. Revenue service was initiated on April 15, 2000 over approximately six route miles, 41 months after provision of Notice to Proceed on the DBOM contract. Currently eight route miles are in service with seven miles presently in construction. Due to the success of the initial DBOM, planning is already in progress for extensions beyond the original 21-mile system. Figure 1 illustrates the current 21-mile system. Daily ridership is currently at just under 10,000. This paper describes the process used to transition from construction to revenue service (commissioning) for the initial segment.
The commissioning process is often the most challenging aspect associated with the deployment of a new passenger railway. On Hudson-Bergen these challenges were compounded by:

- The accelerated schedule and concurrency of activities associated with a Design-Build process.

- Creation of a totally new operating entity, including such factors as formulation of an entirely new set of operating procedures, and protocols, and training and qualification of new employees.

For HBLR a carefully coordinated Commissioning Plan was followed. This plan was based on a step-wise approach to achieving the functionality required at any given time in the commissioning process, rather than being based in purely geographic stages of completion. This plan was referred to as the “Rainbow Plan”. An important aspect of this Plan was its close relationship to final System Safety certification, as well as the issuance of “safety authorizations” which were provided for use of each of the interim configurations. Each interim configuration was assigned a color and represented a phase. Prior to initiating each phase of the Rainbow Plan, the required level of physical completion and the operating functions of each system and subsystem as well as associated levels of training, rules and procedures were defined. Satisfactory completion of “Authorized Lists” led to issuance of Temporary Use Notices (TUNs) for each system and facility. These were based on achieving an acceptable combination of functionality in an engineered system, special procedures which were necessary to mitigate “lost functionality”, and training in place for each level of predefined use for each Rainbow
Plan phase. The TUNs authorized incremental testing and defined the elements to be used and the restrictions to be placed on their use due to reduced functionality.

The Commissioning process described herein is comprehensive in nature and, in addition to Safety Certification, includes:

- Testing at the system and sub-system level

- Integration Testing, i.e., testing which occurs between “systems” or between sub-contracts.

- Training and Qualification of Employees

- Operational Validation. This validates that the engineered systems in concert with the newly established rules and procedures and along with employee training and qualification will achieve the operating requirements. This is a contractual requirement wherein TFCR was required to demonstrate to the owner (New Jersey Transit), all routine and special operations for a pre-determined period of time.

- Operational Demonstration

This paper describes the HBLR start-up with emphasis on how the process consistently satisfied the requirements of the System Safety Plan. The process described in this paper required approximately 15 months from formal beginning of system-wide commissioning efforts to the achievement revenue ready status.
2. **CRITICAL FACTORS**

A number of issues were identified by the HBLR management team during the early planning of the commissioning process. These issues primarily stemmed from the “fast-track” nature of this deployment and the fact that HBLR is an entirely new system utilizing a technology (light rail) that has not been operated in the New Jersey/New York area (with the singular and somewhat special exception of the Newark City Subway) for 50 years. The latter, for example, influenced the level of preparation required in the community for in-street operation.

The most significant issues to be addressed in formulating the commissioning plan were:

- The significant amount of “concurrent engineering” which was occurring as part of the Design/Build process. This was a necessary consequence of the ambitious deployment schedule. Shortening (“crashing”) durations while retaining a “sequential”, conventional deployment process would not have achieved the schedule goals.

- The short time available between completion of the construction or installation of each system and the mandated “revenue ready” date. This reduced the durations available for integrated testing and also limited the time for which that particular system or element would be available to the operations management team for training and qualification of new employees.
• The contractual requirement for self-certification of a new operating transit system by a private operator; this was a first!

• The relative inexperience of the workforce of the new operating group, particularly in the transportation department. Almost all train operators were new to the railway industry, and a large number of line supervisors were also new to railway operations.

TFCR’s leadership team, in cooperation with New Jersey Transit, began detailed planning for Commissioning, with initial focus on “engineering start-up” a full two years prior to the contractually mandated revenue ready date. As trivial as it may sound, first order of business was to standardize terminology, i.e., what is meant by “Start-up”, “Activation”, “System Testing”, “Integrated Testing” and so on. This was a real issue since managers and lead discipline engineers with different technical backgrounds (transportation, construction, and design) used the terms differently. Appendix “A” summarizes the defined usage of the important terms.

In order to address these issues the Commissioning process for the initial operating segment would require the following attributes:

• **Stepwise Functionality.** The process would achieve incremental commissioning of elements (systems, sub-systems, areas) as they became available according to a carefully defined progression. Each step in the process would be based on the minimal level of completion that was required to achieve the functionality defined for that particular phase.
• **Discipline.** Due to the relative inexperience of some of the field forces, particularly as previously noted in the Transportation Department, the process was somewhat dogmatic. A set of Special Start-up and Test Procedures (STP’s) was written expressly for Commissioning. These procedures addressed all aspects of commissioning, from performing engineering tests to establishment and operation of a temporary office until the control center was placed in service. Included in these STP’s were carefully defined protocols, defined below, for transfer of “ownership” from the Construction group to the Start-Up unit to Rail Operations.

• **Ownership Authority.** This needed to be clearly defined between TFCR organizational units. As part of the commissioning “dogma” a specific trail of “ownership” of fixed plant equipment and systems was as defined and illustrated in Figure 2. Under this protocol ownership was jealously guarded to the point where even padlocks on equipment cases were changed upon “turnover” or “release” to a “following” group. Provisions were necessarily made for entry or work by one group into areas or systems owned by another. This, for example, occurred when construction forces entered a system “owned” by start-up in order to complete punchlist items. When this occurred Construction personnel were required to comply with STP’s. An important aspect of “ownership” pertained to electrified energy (traction power, building, shops), and of authority for train movement.

• **Flexible.** While flexibility seems at odds with a “dogmatic” approach, the leadership of the Commissioning team constantly reevaluated status and forecast of schedule progress in order to accelerate required work or establish
commissioning “work-arounds”. In fact, each of the letter descriptions appended to the color phases represents such a work-around. The key to maintaining flexibility in a dogmatic process, was the understanding and “protection” of the “stepwise” progression of functionality.

• Safe. Clearly the most important attribute, this focused strongly on “interim” conditions or use of partially “disabled”/completed engineering systems. Thus a special aspect of the system safety process evaluated and “authorized” (using TUN’s) operation over interim configuration.

3. ORGANIZATION

A “Start-up” unit was organized. This unit was separate and distinct from Construction Division as well as from Rail Operations and reported directly to Program Management at the same level as each of these other units. The Start-Up unit was comprised of a mix of personnel with extensive, fixed plant railway (maintenance of way) experience. Rail experts with experience (primarily in traction power, signals, track and rolling stock) were complemented with personnel with experience in power plants and the defense industry (for fiberoptics, SCADA, shops, traffic system, stations). In particular, personnel with power plant experience were well versed in concepts pertaining to achieving partial functionality in an engineered system or sub-system while protecting the safety aspects of the “missing” functions through procedures or “limited usage” protocols.
4. **THE RAINBOW PLAN**

As previously noted the fundamental basis for establishing the level of completion, by type of system or sub-system as well as by geographic extent was the minimal functionality required to achieve the objectives of that particular phase. This was, in turn, based on a rigorous “backwards” pass along the Program’s Design/Build and Commissioning schedules. This approach was required because the original optimized project logic was at 3 to 4 months’ negative float with 18 months remaining prior to the targeted revenue ready date, with a likelihood of further slip due to unknowns in the areas of “safety certification” and “staffing and qualifying” train operators. Thus, a PERT analysis would have shown an even more critical situation. Under the Rainbow Plan a revised commissioning (as defined including Start-up, Activation, etc.) CPM was developed showing absolute essentials. This schedule was formulated, backwards from the revenue ready date, with zero float. As one would expect, this schedule clearly indicated the critical nature of the test and acceptance of the Light Rail Vehicle (LRV) to the entire commissioning process. This was because the LRV was required for selected integrated tests (e.g., safe braking, dynamic clearances, ride quality, EMI, and pantograph/trolley wire) and to supervisor and operator training, all of which were prerequisite to validating the Hudson-Bergen Operating Plan.

Appendix “C” provides a tabular description of each of the Rainbow Plan Phases, including a “purpose” for each phase. The next step in this “backwards” process was to determine minimal levels of completion of the HBLR fixed plant for each of these commissioning phases. Clearly validating the HBLR Operating Plan required all of the fixed plant to be operable, but earlier “phases” could be accomplished with less. This process of differentiating between what was absolutely essential from the “good to have”
caused the commissioning process to be somewhat less than optimal from an economic viewpoint, but was required in order to maintain total program schedule. Most importantly, adherence to the schedule for revenue service achieved total economic optimization. In the limit, it was determined that the first major tasks, the integration of the sub-systems aboard the LRV (braking, traction power, controls) and the “proof of design” testing of the LRV could be achieved with approximately one mile of single track, and that an old fashioned “baton” could be utilized as a means of train control. The initial commissioning phase, termed the “red” phase after the color used to denote the limits of energized catenary and live track on the “war room” drawings, was accomplished under a railway plant configured as illustrated in Figure 4 and described in the associated Table. During this phase ownership of Red (and its associated “fouling envelope”) was assigned to the Start-up Unit. Construction forces were not permitted to work in Red territory without formal authorization and when they entered were required to comply with the Start-up unit’s STP’s. A temporary movement office was established in a sub-station and a baton (as called for by STP’s) provided authority for train movement. Since Start-up “owned” Red, all involved transportation personnel worked under the tactical direction of the daily Test Manager. Since interlockings were not yet “in-service”, the STP’s required that each turnout be locked and wedged prior to any train movement. Further, since the route between the Red section trackage and the car house remained an active construction site, and remained under Construction’s jurisdiction, the Test Manager was required to coordinate yard moves with Construction’s site manager. The Red “A” phase consisted of approximately 1½ miles of track No. 1 on the Bayonne Branch.

While Red phasing LRV tests occurred on this track, Construction required to initiate vehicle acceptance testing was expedited. This was designated as the Green Phase. A
minimum of 12 (of the total of 29) LRV’s were required to support supervisor and operator training and integrated testing. At an estimated one week per LRV it was essential that capability be provided to test two cars independently, hence two tracks were required. Arrival of the production LRV’s coincided with completion of all LRV acceptance tests with the exception of the “safebraking” function initiated under the Automatic Train Control (ATC) system. Since the ATP sub-system was not operable, these tests were deferred until the train control system was fully functional. Although this could be considered as “doubling” the hill, it was necessary to maintain the commissioning schedule.

The initial Rainbow Plan called for cut-in of the train control system in time for Green Phase; since this did not occur, Green “A” was designated for operation of two tracks using special batons (a “track 1” baton and a “track 2” baton) and the Green territory remained under Start-Up’s control. Consequently, work progressed in accordance with STP’s. Shortly after the initiation of Green “A” the wayside functions of the train control system were placed in service. Unfortunately, unresolved issues caused temporary disablement of the cab signal/ATC sub-systems. Likewise, the OCC was not yet completed. It was now only eight months to revenue ready status and the Leadership Team determined that it was essential that the Rail Operations Department take charge and that, in particular, the Senior Transportation Managers begin to apply the permanent Operating Rules & Procedures. This was considered to be an essential part of the “activation” process. Accordingly, at the commencement of the Green “B” control of “Green Territory” was assigned to Rail Operations, and the LRV Test Manager now worked under the cognizance of TFCRC’s General Manager and, more importantly, tests in Green “B” were conducted under the authority of the Operating Rules & Standard Operating Procedures (SOP’s); the STP’s no longer applied to Green Territory. The new
HBLR Operating Rules were modified to reflect the lack of cab signals and OCC and put into effect as the “Green Rules”. A discussion of the basis for such modification and issuance of a Temporary Use Notice (TUN) by the System Safety Committee is included in the following section. The splitting of the Green Phase into “A” and “B” portions and the formal issuance of the “Green Rules” provide a good example of the apparent oxymoron of a “flexible, dogmatic” approach.

The basic logic shown in Figure 2 is illustrative; its implementation required concurrent progression of activities wherever possible. Consequently, as Green Phase activities progressed on the Bayonne Brach, the West Side Branch and portions of the mainline were moved into the “Orange “A” phase “System Level and Preliminary Integrated Testing”. This territory was “turned over” by the Construction Manager to the Start-up Manager, and subsequently all activities, including train movements (within Orange) were conducted under the STP’s. Immediately following integrated testing the West Side branch along with those cars which had completed commissioning were designated as “Blue” and released to “Rail Operations” for use in operator training. Thus, at approximately six months prior to revenue ready date the status of HBLR was depicted in Figure 5. Likewise, subsequent phases continued to occur concurrently until the entire Initial Operating Segment was released to the General Manager.

The stepwise commissioning of HBLR according to the Rainbow Plan is summarized in Appendix “C”. Two processes which are strongly related to success of the HBLR’s initial commissioning are Systems Integration and Systems Safety. Each of these need to be initiated at the very beginning of a program in order to maximize their benefits.
5. SYSTEM INTEGRATION AND SYSTEMS SAFETY

Systems Integration is a program wide process which initially assures that the design of individual system is such that the Railway’s (or any product’s) operational requirements will ultimately be achieved by the completed systems acting individually and in combination. A fundamental aspect of SI is the early formulation of interface control requirements and criteria, and their formal delineation by Interface Control Documents (ICD’s). Properly optimized design is a deductive process, that is, it is top down where design in each discipline must conform to “System Level” design requirements, and where the ICD’s are the means of assuring such conformance. The list of systems and sub-systems utilized in the HBLR program are listed in Appendix “B”. This classification is recommended as an industry-wide protocol. The approach to Systems Integration used on Hudson-Bergen Light Rail was previously presented at the 1999 AREMA Signals and Communication Conference in Baltimore.

Commissioning and pre-commissioning testing, conversely, is inductive, and works up the hierarchy of each system as illustrated in Figure 6. Integrated Testing, which is near the top of the hierarchy, is based on the ICD’s. If an active SI process has been implemented throughout the deployment cycle (as it should be!), the integrated testing essentially becomes a validation of the original integration criteria and proves that these criteria have been satisfied by the design, manufacture and construction. The keystone of the Integrated Test Plan is therefore the ICD’s.

Under the Rainbow Plan certain systems were placed in service at partial functionality, i.e., with certain sub-systems not in service. A good example is train control during the Green Phase, where EMI issues precluded use of the cab-signal system. The concept of
utilization of a system which is partially disabled is a common practice used explicitly (i.e., well known, well documented, and well controlled) in such industries as power generation and defense, as well as railroading. It is based on a full understanding of the design functionality of each sub-system, and on the integration requirements of each system. The concept of “graceful degradation” (while protecting safety) is critical to use of partial systems. In the case of the Green Phase, the train control system was placed in service with the function of “train separation” performed as if all trains had experienced an “on-board” cab signal failure. Trains were moved using “clear block” (green) aspects on the wayside signals, which could only be displaced if the entire block to the next interlocking was unoccupied, rather than “proceed cab” (Lunar). This method provided normal train routing and broken rail protection, and limited following trains to an approximately six minute headway, rather than the design headway of two minutes. As a consequence, later action then involved subsequent retest of the interface between on-board cab signal equipment and the vehicle traction power and braking equipment.

For each phase of the Rainbow Plan the System Safety Process evaluated:

- The intended operation, i.e., the operation which was required to achieve the stated goal of each phase, including associated test plans.

- The level of system/sub-system completion and the safety of implications of any missing functionalities.

- Mitigation methods which were proposed for that phase, to accommodate degradation of systems functionality.
- Documentation and training of all personnel involved on temporary operating protocols (STP’s, “Green” Operating Rules, etc.). This includes safety critical inspections and tests.

Upon review and findings that all items were compliant, the System Safety Committee issued a Temporary Use Notice (TUN). This indicates that the operations, as stated for that phase in association with the mitigation measures, is safe. The TUN process is maintained as separate and distinct from the Safety Certification process. The latter is directed strictly to certification for revenue operation.

6. CONCLUSIONS

(a) Just as in revenue operation, safety is the highest priority during the commissioning process. The safety of interim conditions, and temporary operations requires careful engineering and operation review through a formal process. On HBLR this was the “Authorization” process, as differentiated from the “Certification” process. Safety “Certification” is reserved for final readiness for revenue service.

(b) The Commissioning Process should be highly disciplined and well documented. A reasoned, dogmatic approach is beneficial, particularly to a new start property.

(c) Concurrent engineering and performance of concurrent construction and testing activities was essential to the fast track deployment of the initial operating section of HBLR. This was most “efficient” in bringing the “product” to the marketplace, but did not necessarily provide the “cheapest” commissioning cost.
(d) A robust System Integration process is absolutely essential to an efficient and safe commissioning process. The most apparent reason is that it provides ICD’s, which are, in turn, the basis for integrated testing. A more subtle and perhaps even more significant reason is that SI is critical to evaluating safety and formulating protocols for test operations which will occur under “degraded” conditions. SI also is critical to final safety certification.

(e) Planning for Commissioning should start early; on HBLR the Start-Up organization was mobilized two years prior to the “revenue ready” date.
ACKNOWLEDGEMENT

The support and cooperation of New Jersey Transit’s executive and technical staff was instrumental in the success of the HBLR. In particular, Jeff Warsh, Executive Director, Dan Censullo, Assistant Executive Director, and Rich Falcon, Director of Systems Engineering provided outstanding leadership during Start-up and Activation. Bob Sedlock of the NJ DOT (System Safety Oversight) offered outstanding insights into the safety of interim conditions.
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<td>Green/Blue/Orange Schematic</td>
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<td>Appendix C</td>
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CONSTRUCTION

Complete sub-system construction and inspection. Complete testing below sub-system level

Documentation & punchlist clearly delineated

Failure

joint review with start-up

If pass, turnover to start-up

“Energy Applied”

Sub-System Testing
System Testing
Integrated Testing
with documentation & punchlist substantially completed

Joint review with Rail Operations passes

Rail Operations Owns; Rules and SOP’s Apply
Figure 3

Dynamic Integration of LRV Subsystems → 2 Prototype LRV’s, Qualification Testing → Initial Fleet of LRV’s, Acceptance Testing → Supervision Training Selected Integrated Testing → Operator Training → Validation of HBLR Operating Plan → Full Demo → Revenue Ready
### SYSTEM LEVEL OF COMPLETION

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>LEVEL OF COMPLETION</th>
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</thead>
<tbody>
<tr>
<td>Track</td>
<td>1 ½ miles: Turnout locked &amp; blocked for all train movements</td>
</tr>
<tr>
<td>Traction Power</td>
<td>1 ½ miles of OCS &amp; 1 Sub-station</td>
</tr>
<tr>
<td>Integrated Control System</td>
<td>Not available, use of radio, temporary movement office, and train sheets</td>
</tr>
<tr>
<td>Train Control</td>
<td>Not available, use of baton</td>
</tr>
<tr>
<td>Shop</td>
<td>Minimal repairs only</td>
</tr>
<tr>
<td>Yard</td>
<td>Under construction, start-up moves through the yard under authority of Construction group</td>
</tr>
</tbody>
</table>

**Figure 4**

Status of HBLR, Red “A” Phase

- **“Y-South” Interlock**
- **Shops**
- **All Systems Except Red under Control of Construction Division**
- **“Red A” Phase**
  - 1.5 Single Track
  - Start-up Control
- **“Y-North” Interlock**
**Figure 6**
**Integration Hierarchy**

**Deployment:**

**Read Down**
- Total Railway → Operating Requirements Documents (ORD)
- Individual Systems → Integration Requirements are Defined
- SUB-SYSTEMS → ICD’S
  - ASSEMBLIES
    - COMPONENTS
    - PARTS
  - Detailed Design Governed by ICD’s and Criteria

**Commissioning**
- Operation Validation (RAIL OPERATIONS)
- Integrated Testing (START-UP)
- Sub-System Testing (START-UP & CONSTRUCTION)
- Construction, Inspection & Testing
- ACTIVATION (RAIL OPS)

**Read Up**
APPENDIX A
DEFINITIONS

These are the definitions as used on the HBLR Program:

1. **Commissioning.** The total of all activities required to transform a new railway from the point at which all construction/installation is completed to revenue ready status. The components of “commissioning are:
   - integrated testing
   - activation
   - safety certification
   - operation demonstration

2. **Systems**
   An assemblage of hardware, software and documentation which is capable of delivering a “high level” stand alone function, e.g., train control. A list of systems and sub-systems, as used on HBLR, is provided in Appendix “B”. On HBLR systems are further broken down into sub-systems, assemblies, components and parts.

3. **Systems Integration** is a program-wide and program-duration process which defines and controls interfaces in order to assure that the operating requirements on HBLR systems and criteria are achieved. SI is intended to provide for total optimization (i.e., to guard against optimization of any system at the expense of another or total railway performance).

   The SI process provides the basis for Integrated Testing, particularly in its generation of ICD’s.

4. **Integrated Testing** is testing which verifies the joint performance of two or more systems, or between selected sub-systems. Safe brake tests and LRV/clearance tests are categorized as integrated tests.

5. **Start-up** includes all engineering aspects of final testing at systems level and integrated testing, and provision of as-in-service documentation.

6. **Activation** pertains to preparation and validation of operating documents, e.g., rulebooks, operating procedures and maintenance plans. Includes developing and validating operating schedules. Also includes defining and staffing the organization, training and qualification of employees. This also includes operational validation, i.e., the sum total of rules, procedures, engineered systems, and training and qualification can collectively satisfy the operational requirements.

7. **Safety Certification.** Verification and certification that all engineered systems and rules and procedures, training and qualification satisfy the requirements of the Program Safety Plan.
APPENDIX "B"
HBLR SYSTEM/SUB SYSTEM LIST
FOR MOS-2

Rail systems

1.0 Rolling Stock
Kinkisharyo Light Rail Vehicle (LRV)
Conrail Vehicles
Work Equipment
Automotive

2.0 Electrification
Substation & Power
Overhead Contact
Stray Current

3.0 Track
Ballasted Track
Embedded Track
Direct Fixation
Special Trackwork
Miscellaneous

4.0 Train Control
Interlockings/Train Routing
Train Separation/ATP
Signal Power
Wayside Equipment
Intrusion Detection
Car borne (Cab-signaling)
Grade Crossing
Track Circuits

5.0 Communications
Telephone
Passenger Info System
Security
Communications Backbone
Radio
SCADA
ITB’s & Interface
Fire Protection/Alarm
Station Stop

6.0 Integrated Control Systems
NT Work Stations/OCC
Software & Equipment
Security Operations
Passenger Info Operations
Tunnel Ventilation
Traffic Op’s Interface Equipment

7.0 Fare Collection
TVM’S
Validators
Software
Fare Collection Modern to NJT

Civil & Facility Systems

8.0 Administrative & Management
Systems Maintenance

9.0 Traffic Operations Systems
Traffic Signal
Bar Signal
Area Controllers
Local Controllers
Cable Network

10.0 Stations & Shelter Stops
Entry Plaza
Platform Operations
Stair Tower/Pedestrian Bridge
Parking
Fire Alarms
Local Communications CCTV

11.0 Right-of-Way
Drainage
Fencing
Structures
Station Slabs
Highway & Street Crossing

12.0 Tunnels
Ventilation
Fire Protection/Alarm
Emergency Egress/Ingress
Structure
Ingress
Drainage
Electrical
Tunnel Floor

13.0 Guideway
At-Grade
Viaduct
Special
# APPENDIX C

**“RAINBOW PLAN”**

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<th>PHASE</th>
<th>PURPOSE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td><strong>RED “A”</strong></td>
<td>VEHICLE SHAKEDOWN</td>
<td>“Shakedown” consists of continuous operation at maximum performance parameters (accelerations, braking, MU Operation) with vehicles 2001 &amp; 2002 in order to identify any immediate corrective actions and to provide a basis for initial verification of the performance of two prototypes. “Shakedown” does not represent a part of the vehicle commissioning process.</td>
</tr>
<tr>
<td><strong>RED “B”</strong></td>
<td>VEHICLE QUALIFICATION TESTING</td>
<td>Qualification testing involves a full range of instrumented testing consisting of dynamic vehicle tests (full acceleration, balancing speed, service braking, etc.) in order to verify design, design integration, and manufacturing of the vehicle but is not intended to accomplish integrated testing or vehicle commissioning. Failures will be reviewed for cause and appropriate rework defined.</td>
</tr>
<tr>
<td><strong>GREEN “A”</strong></td>
<td>VEHICLE COMMISSIONING</td>
<td>Vehicle commissioning begins. Estimated to require 1 week per car. Due to change in date of signal cut-in this phase will be initiated over Tracks 1&amp;2 from Conrail Flyover to S/o Yard North. Will have ability to commission two vehicles at a time.</td>
</tr>
<tr>
<td><strong>GREEN “B”</strong></td>
<td>VEHICLE COMMISSIONING</td>
<td>Vehicle commissioning continues with train control system fully functional for Green Configuration (YS, GR, 34th, SSY and SMY). Train movements will be governed by modified version of the HBLR Rulebook, referred to as “Green Rules”.</td>
</tr>
<tr>
<td><strong>BLUE “A”</strong></td>
<td>ACTIVATION &amp; QUALIFICATION</td>
<td>This phase is intended for training and qualification of operational personnel, as well as for establishing coordination with external agencies e.g. police and fire, and for shakedown of OCC procedures. Will also include APTA &amp; 2nd Peer review. TFCRC revised physical limits of the Blue Phase; deleted west branch, added mainline as far north as Creek interlocking.</td>
</tr>
<tr>
<td><strong>BLUE “B”</strong></td>
<td>ACTIVATION &amp; QUALIFICATION</td>
<td>Activation &amp; Qualification continues with northern mainline limits extended to Canal interlocking with use of one crossover.</td>
</tr>
</tbody>
</table>
| **ORANGE “A”** | INTEGRATED TESTING AND INITIAL OPERATIONAL VALIDATION | Truncated IOS capable of providing service to Exchange Place. The in-service target date is during March 2000. The “Orange” is referred to as IOS-1. The location of the terminal of the terminal crossover will now be on ballasted track adjacent to Harborside. Systems layout (traction power, train control, and communications) requires design. Typical of the activities which are to be performed during Orange Phase include:  
   a. Systems commissioning – includes commissioning and transition to full O&M status of all systems except vehicle (over the geographic extent of the Orange Configuration). Note: vehicles have previously been commissioned in green.  
   b. Confirm and shakedown operational practices. |
| **ORANGE “B”** | ALL SYSTEMS COMPLETED; FINAL OPERATIONAL VALIDATION | This phase validated that the combination of engineering systems, and the staffing and training of the operating organization, could jointly achieve the HBLR Operating Requirements. |
| **DEMONSTRATION** | | Operational demo – In order to achieve service initiation in March. 30 days to make 10. |