# AMENDMENT NO. 2
# **ATTACHMENT NO. 2**

## "CAPITAL ASSET REPLACEMENT PROGRAM

### 3.17.1 SCOPE

The CARP provided at the time of the bid has been updated to reflect the impact of the changes to the CARP resulting from changes in the project schedule and in the scope of works. The key elements of the CARP program are:

- Assets have or will reached the end of their design life;
- Assets cannot be maintained to perform within the limits specified or designed;
- Exhibit a measurably higher failure rate; or
- Cease to be economical to maintain due to wear-out or obsolescence.

Given the design life cycle of the equipment to be provided, in particular the electronic systems, it is likely that some equipment will start to face obsolescence during IOMP-1 between 2020 and 2025.

In order to avoid costly system replacements because a few modules in the system cannot be procured it is necessary to stockpile equipment at "Last Order". This may result in CARP expenditures for last orders during Interim Operating. Periods.

The CARP document:

- Defines a process of continual update and finalization of CARP activities along with the development of the Project; and
- Provides preliminary planning of CARP activities.

Technologies or components involved in the CARP fall into two main categories:

- Elements that reach the end of their design life or uneconomical to maintain; and
- Elements that have become obsolete.

This document will apply to equipment and technologies under Core Systems Contractor's scope of work and MSF equipment and facilities and does not apply to upgrades and modifications required by legislation not mentioned in the tender documentation or issued afterwards.

Concerning MSF supplies, the Core Systems Contractor's analysis has been conducted on the basis of the information presently available, i.e. experience on similar projects and currently available manuals from the Fixed Facilities Contractor.

### 3.17.2 DOCUMENT REFERENCES

- EN 62402 Obsolescence Management – Application Guide (CENELEC)
- TP3 – O&M Performance Requirements
- Maintenance & Storage Facility Design-Build Contract – Technical Provisions

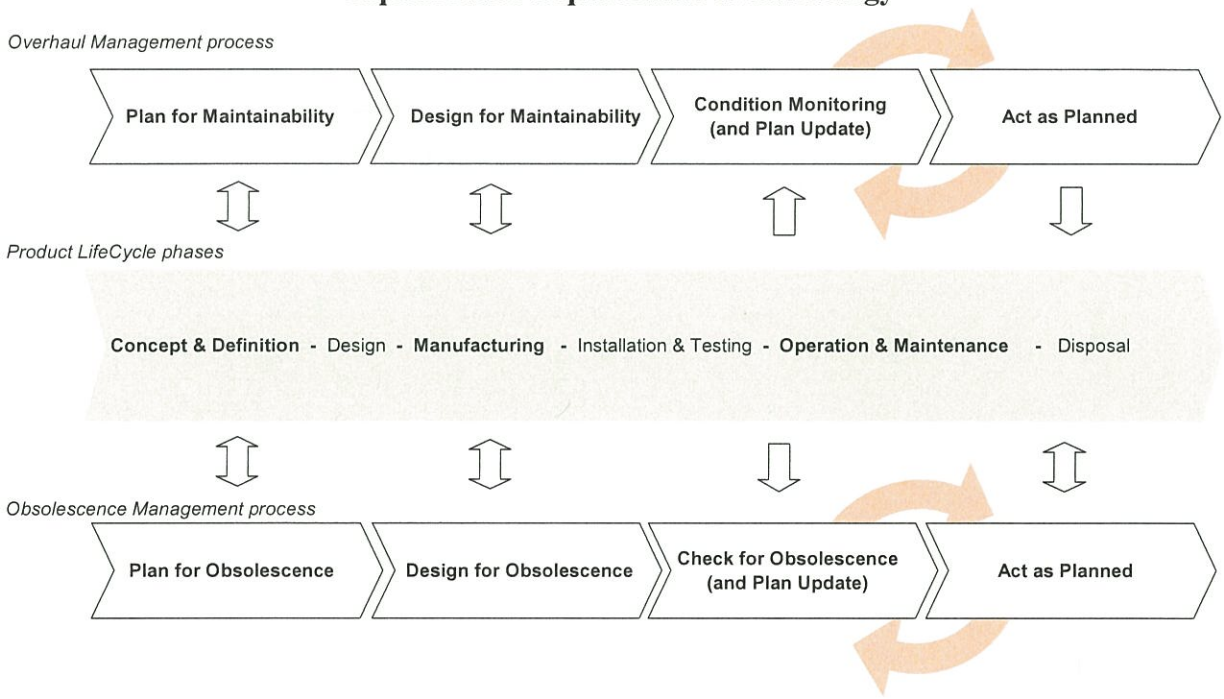
### 3.17.3 METHODOLOGY

The proposed preliminary Capital Asset Replacement Program is divided into two parts:

- Overhaul Program;
- Obsolescence Management Program.

These two processes are described in the Chart: "Capital Asset Replacement Methodology," which follows.

**Figure 1**
**Capital Asset Replacement Methodology**



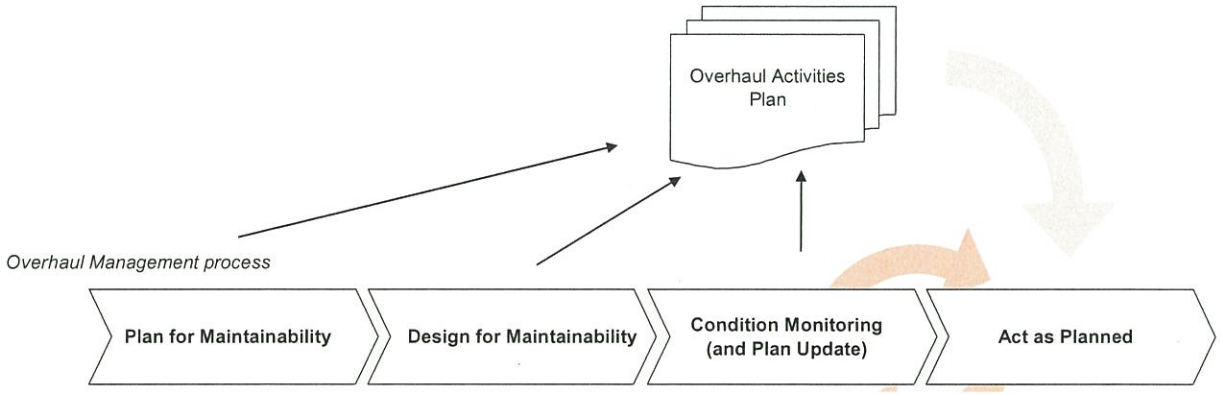
### 3.17.3.1 Overhaul Program

The Overhaul Management process shall define how to handle systems and components when they cease to be economical to be maintained under the routine maintenance program or worn-out components that reach the end of their design life.

The Overhaul Management process includes the following activities:

- *Plan for Maintainability*, consisting in defining the maintainability requirements
- *Design for Maintainability*, consisting in designing and manufacturing the system in accordance with the maintainability requirements, and defining accordingly the relevant maintenance & overhaul plan.
- *Condition Monitoring (and Plan Update)*, consisting in assessment of the system conditions, primarily carried out during preventive maintenance inspections; verification of system conditions in relation to their progressive aging may lead to review the relevant overhaul plan
- *Act as Planned*, which imply the performance of the set of refurbishment activities falling under the Overhaul Activities Plan

**Figure 2**
**Overhaul Management Process**




Overhaul Activities Plan is a mix of manufacturer recommendations and measures based on the experiences acquired on the captioned as well as on other projects.

The activities will be spread-out over a time based or performance based calendar; for elements with a pre-defined lifetime (e.g. vehicle rubber parts), the initial plan will likely be maintained

with limited deviations; for activities based on actual performance, the time schedule may vary depending on the actual systems usage and depending on the outcomes of conditions monitoring activities which may be performed routinely or as spot checks (e.g. random check of components).

All available input will be evaluated for the purpose of optimizing components life and planning preventive activities rather than intervening to correct failures caused by worn-out components.

### 3.17.3.2 Obsolescence Management Program

Obsolescence presents itself when an item is no longer suitable for current demands or it is no longer available from the original manufacturer.

The Obsolescence Management Process consists of the following activities:

- *Plan for Obsolescence*, that shall ensure the adequate selection and timely implementation of all relevant obsolescence activities
- *Design for Obsolescence*, consisting in the implementation of pro-active measures as early as possible (pertaining to the design phase only)
- *Check for Obsolescence (and Plan Update)*, to ensure early reaction and the continuous updating of the obsolescence activity plan
- *Act as Planned*, consisting in applying all appropriate obsolescence activities foreseen in the plan to handle obsolescence when it occurs.

The objective of the plan is to achieve the optimum compromise between life cycle costs for the system, product performance and product availability, maintainability and safety.

The Plan for Obsolescence shall cover:

- Definition of scope and objectives of the plan
- Definition of roles and responsibilities within the O&M company
- Definition of intervals for review of the Plan

The plan shall consider the following:

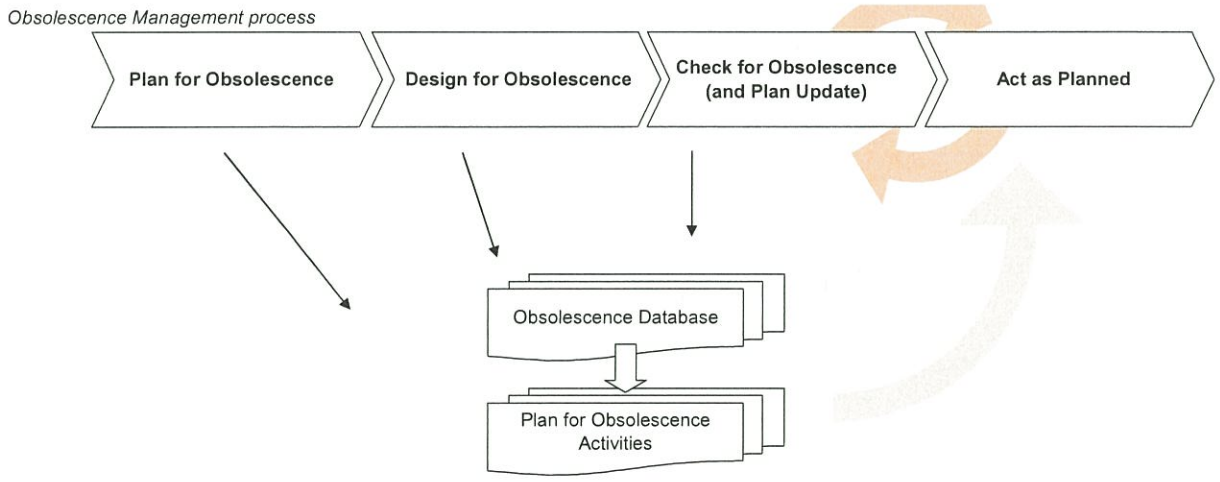
- All in-house processes, skills and infrastructure necessary for production and support of the product and their maintenance
- Compatibility with the customer's current support arrangement

- Identifying the items that present the greatest risk from obsolescence
- Robustness within and environment of change
- Consideration of the need for component, material or product re-qualification following item substitution
- The process of communication with suppliers

The Plan for Obsolescence shall consist, as a minimum is:

- *Obsolescence Database*, covering the detailed assessment of impact, cost and probability of obsolescence; level of detail shall increase with sub-sequent plan updates along with the project lifecycle
- *Plan for Obsolescence Activities*, including all scheduled actions identified as the result of the above assessment, as well as the monitoring steps of the process

**Figure 3**
**Overhaul Management Process**




The *Obsolescence Database* shall be preliminary set-up at component category level following, for example the product breakdown structure of the relevant sub-system.

Most of the obsolescence occurrences are expected to be hardware related, such as:

- Mechanical components;
- Electrical components;

- Electronic components;
- Hydraulic components;

Others fall into the software and systems types of categories:

- The software itself;
- The cables, not from wear and tear standpoint but a performance standpoint.

Guidelines and criteria for the assessment will typically be selected from the following list:

- Systems where the cost for obsolescence is relatively high;
- Where there is a single source supplier;
- When the use of scarce skill is involved;
- Where the component performs a safety critical function;
- Where the product has a long operational life.

The risk over the life cycle of the product can be evaluated, for example, as follows:

- What would be the impact of product being unavailable due to lack of spares
- What would be the impact of performance degradation due to substituted components
- What would be the impact on systems and technologies due to material obsolescence
- What would be the likely cost for premature replacement
- What would be the likely cost of measures to circumvent obsolescence
- What is the probability of obsolescence occurring due to new legislations
- What would be the cost for loss of relevant knowledge and skill base sets
- What would be the impact of lack of documentation
- What would be the impact of loss of access to intellectual property rights

Moreover, the analysis shall consider feed-back and experience from suppliers and partners on the captioned as well as on other projects.

The Obsolescence Database shall include the following information:

1 Item name, identifiers

2 Sub-system or technology

3 OCM(s) and reference to further information about them

4 Supplier and relevant contractual arrangements (e.g. warranty, service contracts)

5 Applicable regulatory requirements

6 Estimation of probability of occurrence of obsolescence in the coming years

7 Estimation of consequences for recovering from an obsolescence situation;

8 Risk evaluation for reactive (i.e. do nothing until the need arise) and proactive strategy (implement obsolescence management measures)

9 Selection of strategy: proactive or reactive;

10 Budgetary situation and precautions

11 Preventive measures to be taken during product life cycle, definition & cost evaluation;

12 Method and frequency of checking for obsolescence.

13 Option for reactive strategies, if applicable

14 Results and outcomes from previous obsolescence concurrencies

The result of the above assessment is the timely planning of preventive and corrective actions (*Plan for Obsolescence Activities*), which may include, for example:

- Planned System Upgrades: this option involves predetermining points during the product's life at which the design of all or parts of the system will be brought up to date and obsolete items replaced. Upgrade of software shall be defined and planned taking into account of the obsolescence of the relevant hardware at the same time. Planned system upgrades are considered:
    - For all new electronic systems;
    - When the time-scale for obsolescence can be accurately predicted;
    - Under circumstances of rapid technological development;
    - When lifetime buy is inappropriate (i.e. short shelf-life);

- When the upgrade implementation carries a high risk.

- Lifetime buy: Purchasing of the quantity of relevant component parts predicted to be required for a defined period. Long term storage costs and conditions will be considered in relation to the part usage rate. A lifetime buy will be considered when:
  - There is a known and predicted obsolescence date;
  - Life expectancy of a system is short;
  - Difficulties caused by future modifications of the part need to be avoided (bridge buy);
  - Avoiding difficulties caused by modifications by the OCM resulting in subtle changes in the construction of products.
- Life Cycle Replacement: systematic replacement of components running out of date
- Re-Training Program: Obsolescence management may also include the maintenance of the relevant knowledge and skill base sets.

Obsolescence monitoring will involve tracking of the processes, materials and components used in the product design through a continuous review and update of the schedule of forecasted obsolescence and relevant activities plan.

Prediction of lifetime for certain electronic components is performed by specialized commercial organizations, such as internet based information systems, that provide assistance in spares scheduling and planning of updates.

In absence of information systems, the customer/supplier timely exchange of information about obsolescence shall allow the monitoring of the availability of their supplied products at regular intervals.

### 3.17.6 CARP PRELIMINARY PROGRAM

#### 3.17.6.1 Preliminary Overhaul Plan

RFCR-00052 requires changes to the CARP estimate d based on the following:

- Increased train miles for IOMP-1, with twenty 4-car trains for 24 months versus the six 2-car trains for 17 months envisioned in Contract;
- Increased train miles for IOMP-2 with twenty 4-car trains for 36 months versus nine 2-car trains for 22 months envisioned in the current contract;
- Increased service hours for IOMP-2 (18 hours, seven days per week) versus the 14 hours during weekdays and 10 hours during weekends and holidays envisioned in the original contract.

As a consequence of the above factors, the train overhaul schedule is expected to change as follows (in each cell the % of the affected fleet is reported):

**Table 1**
**RFCR-00052 vs. Contract - Train Overhaul Schedule**

| | Current Contract | | RFCR-00052 | |
|---|---|---|---|---|
| | *FOMP* | *OOMP* | *FOMP* | *OOMP* |
| *5-year overhaul* | 90% | 10% | 100% | |
| *10-year overhaul* | - | 90% | 50% | |

The above table reflects the spread of overhaul cycles based on RFCR-00052.

To avoid that all the overhaul activities being due in the same time period, the mileage will be planned over the fleet to ensure that there are two groups of ten (10) trains. The first group will have a higher mileage, especially in the first two operating periods, where only 7 or 9 of the 20 available trains are needed for operations. Once the Full O&M starts, the mileage will be evenly distributed.
The following figure indicates how the groups of passenger vehicles will reach the target miles to undergo the various overhaul cycles:

**Figure 4**
**Overhaul of Passengers Vehicles**

| | N. of Vehicles | O&M Int. 1 | O&M Int. 2 | Full O&M 1 | Full O&M 2 | Full O&M 3 | Full O&M 4 | Full O&M 5 | Optional O&M 1 | Optional O&M 2 | Optional O&M 3 | Optional O&M 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N. of Months | | 24 | 36 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 3 |
| Available Fleet | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Required Fleet | | 7 | 9 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Run_Miles (1000*miles) | | | | | | | | | | | | |
| *Calculated Annual Mileage* | | 654 | 1,138 | 2,136 | 2,136 | 2,136 | 2,136 | 2,136 | 2,136 | 2,136 | 2,136 | 2,136 |
| *Average annual mileage (20 trains)* | | 33 | 57 | 107 | 107 | 107 | 107 | 107 | 107 | 107 | 107 | 107 |
| *Calculated O&M Period Milage* | | 1,308 | 3,414 | 2,136 | 2,136 | 2,136 | 2,136 | 2,136 | 2,136 | 2,136 | 2,136 | 534 |
| Fleet Cumulated Age per batch of Vehicles put into service (1000*miles) | | | | | | | | | | | | |
| *Mileage for the first group of trains* | 10 | 131 | 472 | 579 | 686 | 793 | 899 | 1006 | 1,113 | 1,220 | 1,327 | 1,353 |
| *Mileage for the second group of trains* | 10 | 40 | 100 | 207 | 314 | 420 | 527.2 | 634 | 741 | 848 | 954 | 981 |

Light Vehicle Bogie Overhaul, every 500,000 miles corresponding to 5Y
Heavy Vehicle Bogie Overhaul, every 1,000,000 miles corresponding to 10Y

The above scheme is turned into percentage of the fleet to be overhauled by defined dates, as described in the following Table: "Preliminary Overhaul Plan".

## Table 2
## Preliminary Overhaul Plan

| Sub-System | Item Name | Activity | Periodiciy | % of Fleet/Stations Affected | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | FULL O&M Period | | | | | OPTIONAL O&M Period | | | | |
| | | | | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | |
| Passengers Vehicle | Bogie Frame | Light Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | Brake Units | Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | Traction Motor | Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | HSBC | Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | Aux. Unit/Magnet Valves | Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | Brake Calipers | Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | Inverter Fan Motor | Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | Compressor | Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | Air Supply System | Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | Various | Inspection | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | HVAC | Overhaul | 500,000 Miles/5Y | 50% | | | 50% | | | | | | |
| Passengers Vehicle | Bogie Frame | Major Overhaul | 1,000,000 Miles/10Y | | | | | 50% | | | | | |
| Passengers Vehicle | Seats Cover | Replacement | 1,000,000 Miles/10Y | | | | | 50% | | | | | |
| Passengers Vehicle | Doors | Overhaul | 1,000,000 Miles/10Y | | | | | 50% | | | | | |
| Passengers Vehicle | Battery | Overhaul | 1,000,000 Miles/10Y | | | | | 50% | | | | | |
| Passengers Vehicle | Master Controller | Overhaul | 1,000,000 Miles/10Y | | | | | 50% | | | | | |
| Passengers Vehicle | Third Rail Collector | Overhaul | 1,000,000 Miles/10Y | | | | | 50% | | | | | |
| Passengers Vehicle | Gearbox | Overhaul | 1,000,000 Miles/10Y | | | | | 50% | | | | | |
| Passengers Vehicle | Carbody (incl. Bellow) | Overhaul | 1,000,000 Miles/10Y | | | | | 50% | | | | | |
| Passengers Vehicle | Others | Inspection | 1,000,000 Miles/10Y | | | | | 50% | | | | | |
| PDS | UPS - Batteries | Replacement | 10Y | | | | | 43% | | 20% | | | |
| PDS | UPS | Overhaul | 5Y | | 43% | | 19% | 38% | | | | | |
| PDS | HV Switchgears | Overhaul | 5Y | | 43% | | 19% | 38% | | | | | |
| PDS | DC Breakers | Overhaul | 5Y | | 43% | | 19% | 38% | | | | | |
| Communication | OnBoard - Equipment | Overhaul | 12Y | | | | | | | 43% | | 19% | |
| MOW Vehicles | Multipurpose Vehicle | Overhaul | 10Y | | | | | | | 100% | | | |
| MOW Vehicles | Rail Car Mover | Overhaul | 10Y | | | | | | | 100% | | | |

| Sub-System | Item Name | Activity | Periodiciy | % of Fleet/Stations Affected | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | FULL O&M Period | | | | | OPTIONAL O&M Period | | | | |
| | | | | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | |
| MOW Vehicles | Hi Reach Lift Truck | Overhaul | 10Y | | | | | | | 100% | | | |
| MOW Vehicles | Sperry & Geometry Car | Overhaul | 10Y | | | | | | | 100% | | | |
| MOW Vehicles | Tamper | Overhaul | 10Y | | | | | | | 100% | | | |
| MOW Vehicles | Grinding Machine | Overhaul | 10Y | | | | | | | 100% | | | |
| MSF Facilities & Equipment | Vehicle-Washing Equipment | Overhaul | 10Y | | | | | | | 100% | | | |
| MSF Facilities & Equipment | Re-caulk deteriorated control joints | Overhaul | 5Y | | 100% | | | | | 100% | | | |
| MSF Facilities & Equipment | Replace carpet and other floor coverings subject to wear. | Replacement | 5Y | | 100% | | | | | 100% | | | |
| MSF Facilities & Equipment | Paint Walls | Re-work | 5Y | | 100% | | | | | 100% | | | |
| Platform Screen Gates | Rubber parts of Sliding gates, motors/gearboxes, brushes | Overhaul | 8Y | | | 43% | | 20% | | | 37% | | |

Overhaul cycles will include the following activities:

| Sub-System | Item Name | Activity | Periodiciy |
|---|---|---|---|
| Rolling Stock | Bogie Frame | Light Overhaul | 500,000 miles |
| | Brake Units | Overhaul | |
| | Traction Motor | Overhaul | |
| | HSBC | Overhaul | |
| | Aux. Unit/Magnet Valves | Overhaul | |
| | Brake Calipers | Overhaul | |
| | Inverter Fan Motor | Overhaul | |
| | Compressor | Overhaul | |
| | Air Supply System | Overhaul | |
| | Various | Inspection | |
| | HVAC | Overhaul | |
| | Bogie Frame | Major Overhaul | 1,000,000miles |
| | Seats Cover | Replacement | |
| | Doors | Overhaul | |
| | Battery | Overhaul | |
| | Master Controller | Overhaul | |
| | Third Rail Collector | Overhaul | |
| | Gearbox | Overhaul | |
| | Carbody (incl. Bellow) | Overhaul | |
| | Others | Inspection | |
| | | | |
| PDS | UPS - Batteries | Replacement | 10Y |
| | UPS | Overhaul | 5Y |
| | HV Switchgears | Overhaul | |
| | DC Breakers | Overhaul | |
| Telecom | OnBoard - Equipment | Overhaul | 12Y |
| MOW Vehicles | Multipurpose Vehicle | Overhaul | 10Y |
| | Rail Car Mover | Overhaul | |
| | Hi Reach Lift Truck | Overhaul | |
| | Sperry & Geometry Car | Overhaul | |
| | Tamper | Overhaul | |
| | Grinding Machine | Overhaul | |
| MSF Facilities & Equipment | Vehicle-Washing Equipment | Overhaul | 10Y |
| | Re-caulk deteriorated control joints | Overhaul | 5Y |
| | Replace carpet and other floor coverings subject to wear. | Replacement | |
| | Paint Walls | Re-work | |
| | | | |
| Platform Screen Gates | Rubber parts of Sliding gates, , brushes | Replacement | 8Y |
| Platform Screen Gates | motors/gearboxes | Overhaul | 8Y |

In order to implement the above maintenance activities, the HRH CARP will involve the use of the following spare major equipment:

- N. 2 complete bogie sets (i.e. 8 bogies)
- N. 2 complete set of bogie components
- N. 16 Axles Sets

Training of staff in refurbishment of the above materials is also included in the CARP.

### 3.17.6.2 Preliminary Obsolescence Assessment & Activity Plan

HRH's preliminary obsolescence assessment has been limited to identify, on the basis of available information, technologies and areas where a proactive strategy against obsolescence is recommended by experience.

In most cases, although the manufacturer anticipates that maintenance support will likely be ensured up to the end of the Project life, the stock levels will be increased (lifetime buy) during the optional O&M period, as a preventive measure.

A representative list of subsystems with associated obsolescence risk is shown in the following Table: "Obsolescence Activity Risk". In order to keep the risk rating at the same level as the one anticipated at the time of the bid, it is of utmost importance to allow for Last Buy Orders during the Interim Operating Periods.

**Table 3**
**Obsolescence Activity Risk**

| Sub-System | Item Name | Risk |
|---|---|---|
| Control System/SCADA | Wayside subsystem (Microlok II, AF-902,) | Negligible |
| Control System/SCADA | Carborne Subsystem | Negligible |
| Control System/SCADA | OCC/SCADA Servers & Workstations (Hw&Sw) | Major |
| | | |
| | | |
| | | |
| Passenger Vehicle | Various | Negligible |
| PDS | Various | Negligible |
| Communication | CTS Software | Major |
| Communication | Telephone System | Major |
| Communication | PIS | Major |

| Sub-System | Item Name | Risk |
|---|---|---|
| Communication | OCC Software | Major |
| Communication | OCC Hardware | Major |
| Communication | CCTV | Major |
| Communication | Timing Software | Negligible |
| Communication | Timing Hardware | Major |
| Communication | MMIS | Major |
| Platform Screen Gates | DCU, maintenance monitoring system | Medium |
| Platform Screen Gates | Various | Minor |
| | | |
| | | |
| MSF | MOW Vehicles | Negligible |
| MSF | Facilities & Equipment | Negligible |

HRH's preliminary obsolescence activity plan is provided in the following Figure: "Preliminary Obsolescence Activity Plan". Note that "Last Time Buys and Updates" shown in IOMP1 and the first 2 years of IOMP2 are not required to be completed during the Contract Term and therefore have not been included in CARP Pricing. They have been included here information in the event that the City wishes to purchase equipment for the period following the end of the Contract Term.

## Figure 5
## Preliminary Obsolescence Activity Plan

| Sub-System | Item Name | IOMP1 | | IOMP2 | | | Full O&M | | | | | Optional O&M | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
| Control System/SCADA | Wayside subsystem (Microlok II, AF-902, ZC) | | | Last Time Buy | | | | | | | | | | | |
| Control System/SCADA | Carborne Subsystem | | Last Time Buy | | | | | | Upgrade | | | | | | |
| Control System/SCADA | OCC/SCADA Servers & Workstations (Hw&Sw) | | | | | | | | Upgrade | | | | | | |
| Passenger Vehicle | Various | | | | | Last Time Buy | | | | | | | | | |
| PDS | Various | | | | | | Last Time Buy | | | | | | | | |
| Communication | CTS Software | | | | Update | | | | | Update | | | | | Update |
| Communication | Telephone System | | Last Time Buy | | | | | | Update | | | | | Update | |
| Communication | PIS | | Last Time Buy | | | | | | | | | Replacement | | | |
| Communication | OCC Software | | | | Update | | | | | Update | | | | | Update |
| Communication | OCC Hardware | | Last Time Buy | | | | | | Repl. | | | | | Repl. | |
| Communication | CCTV | | Last Time Buy | | | | | | | | | Replacement | | | |
| Communication | Timing Software | | | | | | | | | | | | | | |
| Communication | Timing Hardware | | Last Time Buy | | | | | | Replacement | | | | | | |
| Communication | MMIS | | | | Update | | | | Update | | | | Update | | |
| Platform Screen Gates | DCU, maintenance monitoring system | | | | | | | | Update | | | | | | |
| MSF | MOW Vehicles | | | | | | Last Time Buy | | | | | | | | |
| MSF | Facilities & Equipment | | | | | | | | Last Time Buy | | | | | | |