RAILWAY OPERATIONS AND MAINTENANCE
GENERAL STRATEGY & PRELIMINARY OVERVIEW

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EXECUTIVE SUMMARY

This document provides a general strategy for Moose Consortium railway operations and maintenance for trains, tracks and land corridors, and outlines the required facilities. Regular overnight train maintenance will be required within or nearby terminus municipalities, namely the rural Ontario towns of Smiths Falls, Alexandria, and Arnprior, and the rural Quebec towns of La Pêche (or Chelsea), Montebello (or Papineauville) and Bristol. Major train maintenance work will need to be supported within an industrial zone of either Ottawa or Gatineau. This document briefly describes and explains the key logistical requirements, geographical considerations, physical constraints, requirements and solutions.

1. OPERATING PRINCIPLES AS VIRTUES

Moose Consortium operations are founded upon two principles, or "virtues". That term is used here to mean something more conceptual than values. Virtues have two pragmatic aspects: *intent* and *core competency*. For virtues to be present, people and organizations must possess both the genuine *intent* to apply them as reflected in terms of deliberate choice, understanding, knowledge and preparation, and the *competencies* to do so consistently, predictably and appropriately in a variety of situations. Moose Consortium holds safety and productivity as virtues guiding any commitment of resources and personnel.

- *Safety.* The safety of all people involved drives our planning and execution. This does not rest merely on quantitative statistics, rather it is reflected in qualitative observations at any time. The presence of safety as a virtue will typically correlate with bright and clean workspaces, uncluttered machine shops, organized inventory stores, spotless coach cabins, premium care for locomotives, clean comfortable stations, accessible areas for passengers including people with various limitations, and similar vital considerations.
- *Productivity.* Productivity is also a qualitative and contextual matter, not something that can be monitored just with quantitative statistics. Optimal productivity in terms of intelligent stewardship and whole-system-level efficiency is dependent upon the team's grasp of many factors. All structures, projects, maintenance models and schedules incorporate LEAN Principles from the outset. And all physical systems must be planned and designed in a manner embodies *design-for-manufacturability* and *design-for-maintainability* concepts.[1]

2. INTRODUCTION

To adequately prepare for the potential inaugural run of the Moose passenger rail service, prior to start-up a comprehensive operations and maintenance program will be developed. The key to this strategy is a set of well-equipped overnight "outposts" in semi-rural locations, referred to as "Remote Multi-Purpose Terminals" (RMPTs). They will provide a set of amenities to accommodate the diverse needs of daily servicing, grooming and security of equipment and related assets.

RMPTs play a critical role in the operating plan to ensure operational sustainability, functionality and flexibility. In order to minimize track and wheelage costs, these terminals will accommodate trains to be parked, inspected, serviced, prepared and secured for their next trip. In addition to accommodation and preparation of trainsets, these areas can also serve cross-functional duties as storage areas for materials, equipment and supplies for track and corridor maintenance. Where sensible, these operational maintenance facilities can be adjacent to passenger stations, but this is not necessary and in some cases will not be desirable.

One Centralized Maintenance and Operations Centre (CMOC) will be the hub of Moose systems maintenance. This will be a multi-purpose and multi-faceted facility that includes the Network Management Centre, the Heavy Maintenance Mechanical Centre, locomotive and rail equipment

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1 Sources on *design-for-manufacturability* and *design-for-maintainability*:
- http://www.engineersedge.com/catalog/product_info.php/cPath/21/products_id/28
- https://www.construction-institute.org/scriptcontent/more/ir142_2_more.cfm
- http://www.design4manufacturability.com/books.htm
- http://accessengineeringlibrary.com/browse/design-for-manufacturability-handbook-second-edition#p2000af1099701_3001
- http://msis.jsc.nasa.gov/sections/section12.htm
- https://en.wikipedia.org/wiki/Design_for_manufacturability

storage, administration and executive offices, and a training centre. This facility will require long-term flexibility for eventual expansion in terms of growth in service scale, as well as system development (e.g. incremental electrification of the corridors).

3. ASSUMPTIONS

This preliminary draft operations and maintenance plan is based on the following assumptions, and will be revised as operational plans evolve:

(a) There will be six “Remote Multi-Purpose Terminals” (RMPTs) and one Centralized Maintenance and Operations Centre (CMOC) in Ottawa or Gatineau;

- Maxville, ON
- Smiths Falls, ON
- Arnprior, ON
- Bristol, QC
- Farm Point (Chelsea), QC
- Papineauville, QC

(b) Start-up service assessments will assume use of two Bombardier BiLevel Coaches and one Cab Cars per trainset, with six running trains, plus two spare coaches and two spare Cab Cars. No train supplier has yet been selected, and this train, built in Thunder Bay, Ontario, is a convenient and realistic planning reference.

(c) Each of the six trains will be beginning service every day from the terminus located in the semi-rural towns, and heading into the urban area.

(d) We consider two options for operating train service crews:

Two 8-hour shifts:

- 6:00-14:00
- 13:30-21:30

Two 8-hour shifts and one 4.5-hour evening shift:

- 5:00-13:00
- 12:30-20:30
- 20:00-00:30

4. OPERATIONAL REQUIREMENTS

Maintenance of railway equipment is planned in terms of four layers. Moose Consortium's “Remote Multi-Purpose Terminals” (RMPTs) will be set up to handle (i) scheduled service. The Centralized Maintenance and Operations Centre (CMOC) will support (ii) light maintenance that requires a controlled indoor environment; (iii) heavy maintenance; and (iv) heavy mechanical work. These are summarized below.

4.1 PROVISIONING THE REMOTE MULTIPURPOSE TERMINALS (RMPTs)

Trains will begin and end each day's service at the six terminus location. Therefore to minimize down time and unnecessary “deadheading” of equipment between these termini and the CMOC, the RMPTs will be designed and resourced to perform all “scheduled service” requirements. Each RMPT site will be selected in alignment with the same criteria, and will require similar resourcing and provisioning, however the implementation of each will conform with their respective geographical, regulatory and jurisdictional considerations. The factors to be considered include but are not limited to:

- Close proximity to main track;
- Located in a non-residential area so as not to cause public disturbance or convenient intrusion.
- Geotechnical constraints: It is recommended that these areas be in "high ground", not in low-lying areas prone to flooding, winter run-off, or terrain that is unstable. It is recommended to build on bedrock or stone to ensure consistent support for the weight of trains.
- Secured perimeter with fencing and security cameras
- Proximity to hydroelectric power grid
- Back-up electrical generation capability on-site, secure and noise-insulated
- 600 kVA HEP Panels (Yard Power Units/Wayside Power Units) for overnight work
    - Instead of the diesel motors in the locomotives idling when furloughed, the trainsets are "plugged into" an outdoor all-weather HEP cabinet that supplies electricity from the municipal grid to the train, and metered just as any other hydro user would be. These panels are typically located at either end of the train where the locomotive or controlling cab car is located. They provide 600 kVA (kilovolt-amps) in AC power to keep the train HVAC (heating, ventilating, and air conditioning), engine block-heaters, and to have lighting and security features enabled during locomotive shutdown and functional lock-down. Trains can then be safely occupied for cleaning and maintenance routines, and also there's no ambient noise from running engines.
    - Head End Power (HEP) is a system of electrical power distribution on a passenger train in which an auxiliary motor within the locomotive generates all electricity for internal power (non-traction, or non-motive power uses) needed by the train. Virtually all modern passenger trains have their electrical needs met in this fashion. They are also equipped with a secondary, smaller diesel engine which acts exclusively as an electrical generator. This motor runs at a static rate to consistently produce a current which is carried through HEP cables to the entire train. This current powers all doors, lights, HVAC and other electrical accessories.
- Dedicated storage track adequate for lock-out protection and additional track/future expansion
- Comfortable crew facility with full telecommunications networking, including built-in systems redundancy and resilience capability (to be specified), washrooms, kitchen, cleaning supplies, and proximity to municipal water/sewage connections; also, winter snow clearing considerations including salt and sand storage
- Facilities and equipment for efficient truck-based delivery of supplies and light-to-medium equipment, with logistics handling capabilities (e.g. road access, forklift, etc.)
- Storage area for coach and locomotive parts, coach parts and scissor jack
- Storage area for cleaning and maintenance supplies
- Storage area for right-of-way track maintenance (ties, spikes, rails, signal appliances, etc.)
- Specialized equipment and secure storage for it (e.g. portable stairs/scissor lift on wheels)

- Paved or concrete sidewalks for the length of each trainset for coach cleaning/grooming
- Fall protection at any edges
- Adequate lighting, installed and portable
- Comprehensive “event-management-systems” (EMS) support

4.2 OPERATIONS: REMOTE MULTIPURPOSE TERMINALS (RMPTs)

Moose is developing a regular schedule for consistent high-quality housekeeping of seats and interiors (grooming), inspection, preventative maintenance, service, light repair and clearance-to-operate of trainsets at the six RMPTs. A brief but well-structured “pit stop” program will be performed every time a train changes direction of travel at a terminus, while a thorough “technical audit” inspection will be carried out each evening. Spare coaches and cab cars will be moved during the evening to substitute for any that should be taken out of service for work at the Centralized Maintenance and Operations Centre (CMOC). During operations, onboard staff will also be responsible to continuously be observant for potential risks or anomalies, to retrieve lost/abandoned items, to collect and discard trash, and to report any apparent equipment or environmental issues.

4.2.1 Locomotive or Cab Car at the RMPT

Scheduled Service

- Fueling of Locomotive[2] (two motors) as required
- Checking/topping up of fluids/lubricants
- Locomotive/Coach Brake testing
- Supply locomotive with sand
- Locomotive cab grooming/cleaning/windows/windshield wipers/accessories working
- Bell/Horn Testing
- Locomotive load testing
- Pre-departure inspection
- Compressor oil/component checks
- Auxiliary Power Unit (hotel power) checked, service, oil change, etc.
- Battery checks/replacements on all coaches and locomotives

4.2.2 Coach Equipment at the RMPTs

Scheduled Service

- Cleaning coaches, housekeeping of seats, bathrooms, and general interior (grooming) is required every time a train changes direction of travel.
- Water delivery for bathrooms
- Potable water for use in any confectionary services that are available on train.

2 Modern diesel locomotives can be considered as self-contained versions of electric locomotives. Like the electric locomotives, they have electric drive in the form of traction motors driving the axles and controlled with electronic controls. They also have many of the same auxiliary systems for cooling, lighting, heating, braking and 'hotel' power (if required) for the train. They differ principally in that they carry their own diesel-powered generating station, instead of being connected to a remote generating station through overhead wires or a third rail. The generating station consists of a large diesel engine coupled to an alternator producing the necessary electricity.

- Provisioning equipment for inventories
- Lavatory/latrine service, purging of tanks
- Checking/servicing of accessibility areas
- Coach grooming interior/exterior grooming. (upholstery, carpet car, exterior
- window and carbody washing/cleaning)
- Advertising replacement (similar to OC Transpo Bus Media)
- Heating Ventilation Air Conditioning inspection and filter replacement
- Testing of Emergency Systems
- Re-provisioning of beverage/confectionary car lounge

4.2.3 Fuel Considerations at RMPTs

- There will be <u>no</u> storage of significant quantities of fuel at the RMPTs in storage tanks, nor in-ground supply lines and tanks, nor in fuel tank cars. Operating locomotives will be provided optimally-sized fuel tanks.
- Fuel will be delivered locally by truck. It takes about 30-45 minutes to top a fuel tank (3000-5000 litres). Low sulphur diesel is the preferred fuel choice
- Until location permanence is establish, filling the locomotives can be done on an ad-hoc or scheduled basis at scheduled stops *en route* or at the respective termini during layover. Keeping the tanks topped every day (depending on use) means less time to fill.

4.3 OPERATIONS: CENTRALIZED MAINTENANCE AND OPERATIONS CENTRE (CMOC)

Moose will develop its Centralized Maintenance and Operations Centre (CMOC) incrementally. Initially it will support just a few core medium-to-heavy maintenance functions that depend upon minimal infrastructure, involving fewer than 25 staff, but open 24/7. Site selection will take into account that eventually, as the number of trainsets, service operations and schedules grow, the CMOC would become a very active shop with perhaps three hundred staff working over the course of 24 hours, taking into account all trades, crafts, management and strata. It may be advantageous for Moose to select a site that could eventually support the leasing of space and facilities to complementary businesses and organizations. Moose approaches all of its operations with an openness to cooperate with other railway companies, providers of other modes of transportation, and entities from other sectors.

In other passenger rail systems where an RMPT is used (e.g. GO Transit), a trainset can be changed out during the day at the CMOC. Often a train will be taken to the CMOC for scheduled/required work and will lay over at this location for the day. The afternoon crew will then be informed by shop staff which trainset to use for their evening run back to the RMPT. This underscores Moose Consortium's need for a central location for all equipment, preferable on a route where all such trains would converge. The CN / O-Train yard at Walkley Road is a practical central location.

4.3.1 Locomotive & Coach Maintenance Operations at the CMOC

Light Maintenance Requiring Controlled Environments

- Brake pad/shoe replacement
- Headlight and ditch light replacement
- Oil changes/coolant changes

Heavy Maintenance

- Wheel trueing
  - A wheel lathe is used for turning the rolling profile, flange, and inner face of whole- rolled and banded wheels, for manufacturing new wheel pairs, and for restoring (turning) worn wheel pairs
- Wheel changeout
  - A drop table allows the wheels and associated components to be lowered from the railcar rather than the car itself being lifted
- Drawbar (coupler component) replacement

Heavy Mechanical Work

- Truck changeout
- Traction motor replacement
- Prime mover removal/replacement/rebuild
- Compressor removal
- Alteration/damage to windows/doors/car body/locomotive body
- Locomotive rebuild
- Engine rebuild

4.3.2 CMOC Facilities in Addition to Rail Systems Maintenance

- Executive and administrative offices
- Onsite training facilities

4.4 OPERATIONS: RAILWAY PERSONNEL

Employee work activity involved in the movement of trains or engines must comply with several primary rules and regulations, and both CMOC and RMPT facilities must accommodate these:

4.4.1 Canadian Rail Operating Rules

All employees working with trains will be trained and tested in the *Canadian Rail Operating Rules* (CROR)[3] with 100% compliance 100% of the time for their safety and the safety of everyone around them. This requires training and testing in the various occupational categories, as well as refresher courses and retesting every three years

4.4.2 Work/Rest Rules for Railway Operating Employees

Moose train crews are covered by the Canadian *Work/Rest Rules for Railway Operating Employees*[4] developed under Canada's *Railway Safety Act*. The rules define the requirements for hours of work and rest in order to ensure operating employees remain alert throughout their period of duty. Moose will maintain a fatigue management plan for operating employees.

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3 https://www.tc.gc.ca/eng/railsafety/rules-tco167.htm
4 https://www.tc.gc.ca/eng/railsafety/rules-tco140-364.htm

4.4.3 Railway Employee Qualification Standards Regulations

Moose will ensure that all operational railway employees receive and maintain operations training in accordance with Canada's Railway Employee Qualification Standards Regulations[5] Moose will maintain comprehensive management of personnel requirements, the skill-sets and years of experience required, the on-going training and certifications they will need, and the process by which personnel would get such training and certifications. Staffing and training arrangements for the RMPTs will be determined with input from the CMOC team.

- Initial Number of On-Site CMOC Personnel:
  - 25-30 employees onsite during peak daylight hours.
  - 4-6 employees during the evenings
- Minimum 10 years of high-performance operational experience for all lead roles
- Moose operational railway personnel will be union-based. At their option, these operational workers may choose the Canadian Auto Workers (CAW) Rail Division, or the Teamsters Brotherhood of Maintenance of Way Employees Division / Teamsters Canada Rail Conference.
- Moose will collaborate in skills development and maintenance with VIA Rail, Railterm, National Research Council (Rail Vehicle and Track Optimization Program), and others. This will include access to training specialists with the required credentials, and programs for journeymen, apprenticeship and mentorship.
- Skilled worker categories include, but are not limited to:
  - Certified Mechanics
  - Certified Track Specialists
  - Carded Railway Main Track employees (not sure about using capital letters or lower case in this group of trade names, all five bullets to be consistent
  - Train Service operators (or “Running Trades”), CROR rules card qualified
  - Dispatchers

5. RISK MANAGEMENT AND CONTINGENCY PREPAREDNESS

5.1 Definitions

Expectations develop from two interacting sources. They arise from the information and the concepts that shape our perceptions. And they also develop from the events we experience, remember and account for in our future plans. But the information which arrives, and the pre-exising concepts which shape how that information is perceived, are interrelated because experience over time shapes concepts.

Experience sometimes challenges our concepts, and changes our perceptions. Surprises may be minor or significant, but even minor surprises can accumulate to force the evolution of our concepts, and our perceptions. The longer a certain set of concepts and perceptions is held beyond its time, the greater the surprise and the resultant adjustment.

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5 http://laws-lois.justice.gc.ca/eng/regulations/sor-87-150/fulltext.html

Risk management involves planning for *known* unknowns. In their conceptualization of possibilities, people take account of the probability and magnitude of various kinds of events. Effective risk management aims at keeping the system in a non-failure state with a high degree of reliability.

Contingency preparedness involves, perhaps paradoxically, planning to be surprised, or preparing for the potential there may be *unknown* unknowns. This requires people to realize that adverse events can occur which may seem entirely fortuitous, and would have seemed unpredictable in the context of the set of concepts and perceptions held at the time. If such an occurrence should come to pass, it would constitute a decisive surprise. Effective contingency preparedness aims to strengthen an organization's resilience: its ability return to non-failure state after a failure has occurred.

5.2 Operational Contingency Preparedness

In an *organizational* context, preparing to be adversely surprised is an intrinsically collaborative responsibility amongst jurisdictions, sectors and organizations. Moose will establish operational relationships with and through the Canadian Public Safety Operations Organization (CanOps)[6] and its multi-jurisdictional and inter-sectoral Multi-Agency Situational Awareness System (MASAS).[7]

In terms of *practical system design*, contingency preparedness involves building in multiple layers for response, recovery and continuity. This can be illustrated with two tangible examples:

- Moose will actively finance and develop rails-WITH-trails[8] where physically feasible along the railway corridors. In the narrower risk management context, safely designed cycling and pedestrian trails alongside railway corridors remove the incentive for local residents to walk on the tracks. Less obvious is the more strategic contingency preparedness context. Such trails also serve as potential access routes for emergency vehicles which can dramatically improve any type of incident response capabilities. The majority of track is typically difficult or impossible to reach by road. In the meantime, the public would enjoy day-to-day recreational use of these trails.
- The business model upon which the Moose Consortium is being developed makes it both attractive and feasible to include public amenities such as walk-in medical clinics at each the Linked Localities. In the narrow risk management context, such clinics serve to address the set of health and safety issues that can be expected to arise from time to time in any public space. However to strengthen its overall contingency preparedness, Moose will fund and arrange for railway-related emergency response training to personnel at all of these clinics. As a result, each station as well as the entire the network of access routes for emergency vehicles along the tracks will be strategically enhanced with a network of trained medical and emergency response professionals. In the meantime, the public would enjoy greater day-to-day access to routine health care.

5.3 Operational Risk Management

As a normal part of railway operations there are many possible scenarios that could play out in singular or multiple events. Such issues can include:

5.3.1 Mechanical Breakdown of Trains and Railway Corridor Equipment

Locomotives, coaches, track and crossing equipment are all engineered for high reliability, yet they are complex. The failure of a single sensor will literally stop a train in its tracks. All equipment has a

6 http://www.canops.org/
7 http://www.canops.org/?page=AboutMASAS
8 See: *Rails-with-Trails: Lessons Learned: Literature Review, Current Practices, Conclusions.* US Dept of Transport. http://www.fhwa.dot.gov/environment/recreational_trails/publications/rwt/page00.cfm

mechanical failure rate. But equipment that is maintained in less than excellent condition faces a much greater risk of mechanical or electrical failure. Inattention to track maintenance increases the risk of derailments. Inefficient management of equipment and infrastructure failure risk has exponential implications for train operations, for the business, and for many direct and indirect stakeholders. Section 2 above referred briefly to *design-for-maintainability* principles. Such principles set the stage for high performance, and are therefore integral to Moose's forward approach to risk management.

Even minor temporary train breakdowns can create significant problems for other stakeholders. Therefore Moose rail operations will always have at least one standby “rescue” locomotive located at the CMOC, ready to mitigate service disruption in the event of a train failure. Always on call at the location with a standby crew, it could dispatched within minutes to optimize service continuity. The disabled equipment could be handled from either end, pushed or pulled to a siding or spur, and after hours to an RMPT or the CMOC.

When secondary railway undertakings operate on VIA Rail tracks, a delay penalty clause is usually included in the terms of the conditions and concessions of agreement. This can vary between $1500 and $1700 per minute. When a Moose locomotive or trainset experiences a mechanical failure *en route*, it will be of highest priority to have the recovery crew and back-up locomotive ready to go on short notice. (For example, Metrolinx (GO Transit) maintains an on-duty spare crew and train at rush-hour periods at their Willowbrook (Port Credit) facility. Moose will also make operational arrangements with the other railway companies for a shared train back-up plan.

5.3.2 Severe Weather Damage

The Ottawa-Outouais region is home to some of the most severe temperature swings in North America. Over the course of a calendar year, ambient temperature spreads can be -40C to +40C, made even more intense with sun, wind and humidity factored in. This can lead to overheating, HVAC failures, ruptured engine component gaskets, frozen train lines, brake lines, sensors, switches and signals. In addition, extreme rainfall, snow fall, and freezing rain can degrade electrical systems, communications and functional equipment, and damage track, switches, and signalling systems, and can cause fallen trees, washouts, ice build-up and diverse other risks.

5.3.3 Grade-Level Crossing Collisions

The existing railways of the Greater National Capital Region involve numerous grade level crossings and it would be impossible to grade-separate more than a few of these. In recent years such crossings have become subject to increased risk both due to greater driver distraction, and also because train travel has for some decades been uncommon. Moose will proactively exceed Transport Canada's requirements of basic safety standards. The Consortium will develop arrangements with the Railway R&D section of the National Research Council to test options for enhancing safety at grade-level crossings with all-weather retractable bollards, additional visual alerts, and a network of smart sensors.

5.3.4 Vandalism

Rock throwing, paintball, track obstructions and even graffiti can jeopardize train movement and compromise the safety of passengers and railway workers. Sometimes vandalism involves intentional damage. More often it is carried out as pranks, without attention to the potentially serious consequences. Several approaches are required to prevent, control and respond to vandalism: education; social programmes; engagement of the criminal justice system; and opportunity reduction. Where railway property has been damaged or defaced, it is essential to spot the problem and repair it rapidly.

5.3.5 Acts of Aggression / Terrorism

Railway systems are just as vulnerable to attack as any other widely distributed infrastructure. Although the statistical risk posed to individual travellers is minuscule, Moose understands that a goal of attackers can be to incite general public fear or amongst a particular part of the community, or to harm a particular individual. Incidents may be large and coordinated or small scale down to the level of individual assaults. Perpetrators might employ advanced or rudimentary technology.

Moose is pro-active in coordinating its prevention, response and investigation approach through the Canadian Public Safety Operations Organization (CanOps). Moose will also creatively deploy advanced detection systems to pre-empt attacks, as well as to expedite effective response and investigation.

LIST OF ACRONYMS

- CanOps: Canadian Public Safety Operations Organization
- CMOC: Centralized Maintenance and Operations Centre
- CROR: Canadian Rail Operating Rules
- EMS: Event-Management-System
- HVAC: Heating, Ventilating, and Air Conditioning
- HEP: Head End Power
- kVA: kilovolt-amps
- MASAS: Multi-Agency Situational Awareness System
- RMPT: Remote Multi-Purpose Terminal

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