



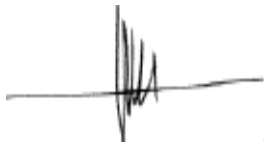
Red Line Master Schedule

Version 10.5 Analysis

Feb. 2016

IDENTIFICATION

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1. EXECUTIVE SUMMARY

GENERAL COMMENT:

This report analyses last version issued by NTA of the Red Line master schedule (V 10.5) issued/submitted to EMC Q4/2015. The 10.5 schedule was built using June 2015 data as baseline, and accordingly doesn't match anymore with nowadays project status. A new version will be issued by NTA in next couple of weeks.

COMPARISON V10.5 VS V 10.4:

In comparison with V 10.4, V 10.5

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

PROJECT STATUS ON FEB. 2016:

On Feb 2016, some tasks, such as station works or SDAG tender, have not yet started or started later compare to what was planned on V10.5. Nevertheless for most of sites, after a usual learning curve period of few weeks, NTA reports that weekly progress for critical activities such as diaphragm wall is higher than planned (on V10.5) which would help NTA to mitigate current delays on stations schedule.

[REDACTED]

[REDACTED]

[REDACTED]

STRONG REQUEST FROM EMC TO NTA:

For next version (V 10.6) EMC asks to NTA to produce, as an addendum of schedule, a formalized mitigation plan (a 3 – 4 pages note) which will give answers to following questions:

- Which mitigation measures (acceleration, strategy/sequence changes ...) have been undertaken in new version in order to cope with new delays (VS V10.5)?
- Are there still buffers, where are they and how long are they?
- Are there specific tasks (e.g.: main utilities diversion, interface design milestones ...) at a level of risk such higher that they could impact PTO dates.

3. VERSION 10.5 OVERVIEW

3.1. PRELIMINARY REMARK:

This version 10.5 has been issued mid-October 2015 and built using June 2015 data. Taking into account real progress of project today, this version 10.5 is no more accurate. As announced in NTA's December monthly report, a new version will be issued (10.6) early in 2016.

Nevertheless EMC performed a detailed analysis of 10.5 version. This analysis could be used by NTA as a guideline to build new version of schedule.

3.2. COMPARISON 10.5 VS 10.4

At macro level main differences between versions are:

- PTO *phase 2* is still end of Oct 2021 : no change
- PTO phase 1 & early operation has been delayed by one year : from Sept 2019 to Sept 2020
- At grade South :
 - o Shift by one year of all activities to be done by SDAG.
- Western TBM :
 - o D wall activities for most of the stations
 - Shift of start by 4 month from July 2015 to October 2015
 - o Most of tasks following TBM completion have been squeezed by an equivalent duration.
- Turkish Alignment :
 - o Total duration for construction reduced from 37 to 30 months
- Eastern TBM :
 - o D wall activities for 2 stations
 - Shift of start by 4 month from July 2015 to October/December 2015 to march 2016
 - o Completion of station delayed by 7 months
- Testing and commissioning :
 - o Task which reflects a 2 months' separate trial running for ATO is no longer shown on schedule.

Conclusion:

- No change for PTO phase 2
- 1 year delay for PTO phase 1 and Early operation

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- Several month of buffers have been consumed for civil works
- Testing & Commissioning strategy has changed and shortened.

3.3. PROJECT PROGRESS JUNE 2015 / FEB 2016

Before release of the new version (V10.6?), it seems important to analyse factually last progresses on RL project and specifically to compare what has been planned and shown on 10.5 and what has really been done between June 2015 and Feb 2016.

- Issue of SDAG tender planned on November 2015 but publish done on February 2016.
- In 4 stations D wall activities not yet started
- Design & Permitting for chambers 1/ & 2/6 not yet achieved

This comparison is not exhaustive and stays at a macro level

Conclusion:

Recent delays will have to be taken into account in new version V10.6 and have to be mitigated to keep PTO phase 1 & 2 as it is shown on 10.5.

4. VERSION 10.5 DETAILED ANALYSIS

4.1. METHOD

To carry out this analysis we used an iterative method in full cooperation and transparency with NTA:

1. End of 2015 : First analysis by EMC => Remarks & questions formalized and submitted to NTA
2. January 2016 Analysis by NTA of Remarks & questions by EMC => Answers and additional information formalized by NTA and issued to EMC
3. Feb 2016 : last analysis by EMC taking into account answers and additional information => Conclusion by EMC for each items
4. Feb 2016: Final review of EMC conclusion for each item done by NTA and additional information and justification have been given. Nevertheless conclusion for each item has not been changed by EMC.

4.2. INPUTS DATA

The documents produced by NTA taken into account in this report are the following:

- Time-chainage diagram (Tilos chart), version 10.5.
- Red Line master schedule (Primavera file).
- Executive summary (Primavera Gantt chart).
- Narrative statement.
- Critical path (Primavera Gantt chart).
- Tender Process.
- Change Log report from 10.4 to 10.5.

4.3. ISSUES RAISED by EMC, ANSWERS by NTA, CONCLUSION

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ISSUE 1. COMPARISON OF THE VERSIONS 10.5 AND 10.4

A. Issue raised by EMC

This table shows the major differences regarding the task durations between the version 10.5 and the version 10.4 of the Tilos charts carried out by NTA. The commissioning date remains the same between the 2 versions (October 2021).

Inputs: Tilos schedules and narrative statements.

Object	V10.5	V10.4
GENERAL		
Issued/Updated	October 2015	September 2014
UNDERGROUND		
Start of TBM boring	TBM 1 – April 2017	TBM 1 – January 2017
Completion of tunnel boring by TBM's	TBM 6 – March 2019	TBM 6 – January 2019
Completion of post-TBM works in the tunnels	February 2020	December 2019
AT GRADE		
At Grade South	All the activities are shifted by one year. The end of the trial running is now set in September 2020 instead of August 2019.	
At Grade East	No more interim version phase in version 10.5. Unique commissioning date (together with the UG section) in October 2021.	
DEPOT		
	All the activities are shifted by about one year.	
End of trial running	Mid-2019	Mid-2018
ROLLING STOCK		
	All the activities are shifted by 6 months.	
Pre-series supply	March 2018	October 2017
LRV 4-90 supply	From December '18 to July '21	From June '18 to Jan. '21
TESTING AND COMMISSIONING		
Subsystems commissioning tests	3 months	2.5-3 months
Test running	4 months everywhere	Between 3 and 12 months
Trial running	2 months everywhere	Between 2 and 4 months
Commercial operation	Commercial operation for AG South in September 2020 and a unique commissioning date for the whole line (exc. Carlebach) in October 2021 and inc. Carlebach in June 2022	Multiple interim phases

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B. Answers by NTA

No comment from NTA

ISSUE 2. UNDERGROUND SECTION

A. Issue raised by EMC

The underground section is on the critical path of the project for the overall service of the line. Several sub projects and activities in the underground section have the potential to constitute the precise critical path under various circumstances. Our analysis of the schedule shows that in any case the construction of the underground stations is on the critical path.

Version changes (10.4 -> 10.5):

The major difference between the version 10.4 and this new version of the schedule is that the main works *have been delayed by several months*, while the overall durations of the activities *have remained the same* and the commissioning date has *also remained the same*.

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B. Answers by NTA

The period for trial running was reduced after discussions with the shadow operator and is in line with historical durations for similar systems abroad. The testing and commissioning period for the At Grade South operation will provide experience, therefore, reducing the learning curve on the main line. All site specific systems will be integrated and tested prior to overall subsystem integration and interface testing.

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C. Conclusion by EMC

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A. Issue raised by EMC

The actual deployment of the contractors and specifically the start of the major construction activities in the stations are late throughout the sub projects that have already began (stations' boxes activities within TBM West agreement and in Carlebach) and are forecasted to be late in the sub projects yet to begin (TBM East).

The major construction activities starts were/are already late in 1- 5 months, depending on the station.

The highest schedule related risk that becomes apparent in the underground section is the TBM drives from Galei Gil to the West, through Arlozorov, Shaul Hamelech, Yehudit stations and up to Carlebach. In this segment:

- All three stations along these TBM drives have late starts.
- Shaul Hamelech and Yehudit stations face problems related to utilities and neighbouring existing infrastructure that will most likely delay further until substantial civil activities commence.
- The main activities at Arlozorov which were forecasted in the schedule to be significantly shorter than in other stations due to the relatively segregated site and no phasing due to traffic diversions, started with work rates that do not exploit these advantages (for example, only 1 D-wall hydromill excavator is deployed), thus resulting in potential doubling (from 6 to 12 months) of this critical path activity.

The launching of the 2 TBMs from Galei Gil Westward is dependent on the readiness of the stations en route, first of which is Arlozorov which need to reach a certain level of readiness in order to accept the breakthrough of the TBMs. Summarizing the above, then forecasted launch of these TBMs is to be delayed by 6-8 months (from mid-2017 to Q1 2018). This Activity has a direct effect on the project's overall duration since buffers that were initially reduced to a minimum in schedule versions were already used by the late starts.

Other TBM launches are expected to be late in several months in the same manner due to late starts in the remaining stations' boxes.

In addition to the effect on tunnel boring starts, another effect of late starts in stations' boxes is the risk that the aggregate of activities' durations in each of the stations could either delay the commissioning of the full project or lead to a case where some of the stations will not fit with the commissioning date of the full line and impose partial operations (excluding these stations from the service – i.e. trains not stopping there).

All the difficulties described above highlight the need for buffers within the activities (see item 6.1) as a measure of mitigation and securing the commissioning date.

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B. Answers by NTA

EGIS states that "Arlozorov, Shaul Hamelech & Yehudit- all three stations along the TBM drive have late starts": [REDACTED]

[REDACTED] In order to mitigate the learning curve, 10.5 contains production buffers in the construction activities for D-wall and excavation. [REDACTED]

[REDACTED]

At Arlozorov, the slow rate was in accordance with the expected learning curve and the contractor can work there 24x5 as a contingency plan to close the gap (permit for night works given by Tel Aviv municipality). As mentioned above, the expected D-Wall production rate is exceeding the 10.5 assumption. Therefore, we do not agree that the TBM from Galei Gil to Arlozorov will be delayed in 6-8 months.

[REDACTED]

[REDACTED] There is also float (hidden buffer) between the contractual milestone dates and the 10.5 early finish dates for TBM-East and TBM West.

C. Conclusion by EMC

[REDACTED]

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ISSUE 4. YET AWARDED PACKAGES/CONTRACTS
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A. Issue raised by EMC

The start of TBM and Stations' boxes East Segment is late in about 5 months vs. the planned dates in this version of the master schedule. The effect should be quite parallel to the effect of the late start of the activities in the Western segment, [REDACTED]

[REDACTED]

B. Answers by NTA

The TBM East NTP was delayed only 1.5 months against 10.5. Ben Gurion and Aharonovich permits have been received and the Bi-furcation chamber permit is on target. [REDACTED]

[REDACTED]

C. Conclusion by EMC

We accept NTA's reply regarding the shorter delay in NTP.

The implementation of TBM tunneling in Axis 1 & 2 from Shenkar to the bifurcation chambers has a significant effect on tunnel end to end completion [REDACTED]

[REDACTED]

ISSUE 5. INTERFACING UTILITIES

A. Issue raised by EMC

Across the project some utilities' diversions are taking longer times than expected or have not started. In this sense we can mention inter alia: Mekorot pipe over the main tunnels in Em Hamoshavot, Tashan (Oil) Pipe in Em Hamoshavot, utilities in Yehudit Station, and interfacing walls in Shaul Hamelech station.

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B. Answers by NTA

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This plan is technically sound, and a meeting with international expert and the respective utility owners arranged to 26/01/2016.

C. Conclusion by EMC

Regardless of the cause for delays in the utility relocation, these delays represent a major risk for the feasibility of the tunneling starts.

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Nevertheless, if there are new developments and agreements with the utility owners, as well as developments in the execution of work in the relocation works itself – it should be translated to an updated version of the schedule.

ISSUE 6. PARALLEL ACTIVITIES PLANNED:

A. Issue raised by EMC

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C. Conclusion by EMC

We accept NTA's answer. If "hopping" TBM logistics from the launching shafts to UG station is envisaged, then it should be reflected in the schedule.

ISSUE 7. AVAILABILITY OF TURKISH ALIGNMENT SECTION

A. Issue raised by EMC

This part of the project is scheduled to be tendered out in the last quarter of 2016 for a design-built tender. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

B. Answers by NTA

A detailed schedule for the construction activities was developed outside Primavera to support this duration of excavation. This detail will be added to the next Master schedule version. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

C. Conclusion by EMC

Detailed schedule for the construction activities described in NTA's answer has not been transmitted to EMC for review. It has to be sent jointly with next version of schedule.

ISSUE 8. AT GRADE SOUTH SECTION

A. Issue raised by EMC

In the At Grade South section, in terms of scheduling, all the activities have been delayed by 12 months in version 10.5. Commercial operation in this section will be effective in September 2020. This target date is subject to the actual mobilization of the SDAG contractor.

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B. Answers by NTA

10.5 assumed publishing the SDAG tender on 15- Nov-2015, with a current forecast of Feb 2016.

C. Conclusion by EMC

We agreed the answer, Indeed the issue of the SDAG was unknown at the date of issuing this report's draft and the actual issue was even earlier than expected,

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With the award of SDAG contractor mitigation should be assessed and implemented.

A. Issue raised by EMC

The activities that set as a condition for start of construction (mainly permitting) in the Eastern section are not completed to the best of our knowledge. However, the delay described above (item 5.1) in the award of SDAG allows to complete these enabling activities in a way that it will not result in further delays.

B. Answers by NTA

No answer by NTA

A. Issue raised by EMC

Tunnelling in axis 1 & 2 from Shenkar to the bifurcation chambers, which to our understanding is now determined to be done by TBM is not represented accordingly in the version of the schedule and thus cannot be assessed.

B. Answers by NTA

The TBM-East contract allows for this section to be performed as either TBM or CTM as determined by the Contractor. Therefore, 10.5 does not dictate a preference. The chosen contractor nominated in his offer TBM construction, so this will be updated in the next version

C. Conclusion by EMC

We accept NTA's reply regarding the change to TBM mode of construction.

We would like to remind that The implementation of TBM tunnelling in Axis 1 & 2 from Shenkar to the bifurcation chambers has a significant effect on tunnel end to end completion which in turn has transverse effects on project wide activities linked to the availability of the full tunnel – these effects have to be studied and the implications translated to the next version of the master schedule.

A. Issue raised by EMC

This section' infrastructure works are not mentioned in this version of the schedule, nor the works relevant to the link to existing Israel Railways station.

B. Answers by NTA

The interface is shown in 10.5 (See Fig. 1 – Page 4) and assumes the existing IR stop will be modified to accommodate a pedestrian underpass from the LRT stop to the IR station.

C. Conclusion by EMC

We agree to the answer

NTA took into account our previous comments about the multiple commissioning dates. It is now more secure to operate the At Grade East section after the major civil works in the tunnel section, and to propose a unique commissioning date for the underground and At Grade East sections (Phase 2).

ISSUE 12. Redundancy in the Schedule

A. Issue raised by EMC

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[Redacted text block]

[Redacted text block]

B. Answers by NTA

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[Redacted text block]

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A. Issue raised by EMC

Following the delays foreseen in the award of SDAG (see item 5.1 above) and the derived latencies in the depot's availability and of early operations of the south at grade, it could be deduced that some adaptations to the internal schedule of the Rolling Stock supply agreement should be introduced including inter alia the postponement of pre series supply and potential spacing in the delivery of LRVs, both for the batch of first 22 double cabbed vehicles (meant for early operations in the south) and the rest of the fleet to align with actual progress in the rest of the project.

B. Answers by NTA



The versioned Master Schedule will evaluate the EGIS observations and incorporate if necessary. Timing of Rolling Stock delivery will be adjusted once the SDAG NTP can be reasonably forecast.

C. Conclusion by EMC

RS agreement is awarded and NTP given. SDAG was recently launched. All conditions are met for a version supply schedule as per our initial remarks.

A. Issue raised by EMC




This package's procurement strategy was recently changed from build only (with full employer's design) to design & build. This entails that detailed design for the stations' finishes, tunnel ventilation, Electrical-Mechanical-Plumbing etc. will start only after awarding this contract. As far as we are aware, the issuance of this tender is scheduled for the last quarter of 2016, which in turn entails that award of the contract is forecasted to third quarter of 2017 and actual design works on these disciplines will commence only towards the end of 2017. This forecasted look ahead creates various risks of which the most severe are:

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- Prolongation of the uncertainties around power loads of the underground stations and type and specifications of supplied systems, both essential for Operation and Maintenance tender.

B. Answers by NTA

The Fit Out tender in 10.5 is planned to be published in June 2016 (2nd quarter) and is on target. We do not understand EGIS's comment regarding publishing the tender in the last quarter of 2016. Consequently, contract award is on target for June 2017 (2nd quarter) and not the third quarter of 2017 as suggested. Nevertheless, this timing allows for adequate duration for design. Permitting of the station inner boxes are being acquired by NTA and are on target.

C. Conclusion by EMC

We agree to the reply concerning timeline precision but NTA have to bear in mind that 

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A. Issue raised by EMC

The award of the O&M agreement planned in this version of the schedule for July 2016 is not achievable. A reasonable forecast for the award of the agreement is the first quarter of 2017. With the described delays forecasted, due mostly to civil works and SDAG, this delay has no significant implications.

B. Answers by NTA

10.5 assumes a publish date of Dec 2015 and an award date in July 2016. The currently forecasted dates are to publish in March 2016 and award in Dec. 2016. These dates have been implemented in the current schedule and will be reflected in the new version.

C. Conclusion by EMC

Agreed.

A. Issue raised by EMC

The availability of the TAMACC at the dates specified in this version of the schedule is questionable. A key milestone such as the tender for its construction is not foreseen to be met. Thus the risk of late completion of the Red Line's OCC and a potential effect on the line's commissioning is present.

With the described delays forecasted, due mostly to civil works and SDAG, this delay has no significant implications, and on the other hand gives a window of opportunity to secure the OCC's location in TAMACC

B. Answers by NTA

This tender is now planned to be published a year later than planned (June 2017). The initial construction duration was significantly reduced to a more realistic value, consequently the completion of the TAMACC (OCC) will not be later than required in v10.5. If, however, there is a delay, mitigation strategies are available for operating the Red Line from the temporary OCC in the South and/or from the secondary OCC at the Depot.

C. Conclusion by EMC

We accept NTA's answer about the rescheduling of the TAMACC – it should be reflected in the new master schedule.

We do not agree the answer regarding use of secondary OCC as primary one since it does not allow acceptable redundancy as required for a SIL4 system.

A. Issue raised by EMC

The procurement of this central subsystem has not yet began and is not represented in this version of the schedule.

Final policy has to be defined and deployment scheduled. In any case AFC has to be operated and ready for the South At Grade Phase 1.

B. Answers by NTA

10.5 assume a designer would be identified in June 2017. The current procurement strategy for design is with the SDAG package. Equipment purchase and installation as an option deleted according to MOF decision. Additional schedule details will be introduced once more information is available.

C. Conclusion by EMC

NTA's answer is now outdated due to GOI's recent directives regarding the exclusion of this system out of the SDAG tender. Once an approach is determined, its schedule derivative should be incorporated into the new version of the master schedule.

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EMC Issue No.	Title	EMC Conclusion Statement	PMC Comments
9	At Grade East section	<p>The activities that set as a condition for start of construction (mainly permitting) in the Eastern section are not completed to the best of our knowledge. However, the delay described above (item 5.1) in the award of SDAG allows to complete these enabling activities in a way that it will not result in further delays.</p>	At grade East final traffic design and permits are on target.
10	Axis 1 & 2	<p>We accept NTA's reply regarding the change to TBM mode of construction.</p> <p>We would like to remind that The implementation of TBM tunneling in Axis 1 & 2 from Shenkar to the bifurcation chambers has a significant effect on tunnel end to end completion which in turn has transverse effects on project wide activities linked to the availability of the full tunnel – these effects have to be studied and the implications translated to the next version of the master schedule.</p>	Axis 1 and 2 tunnel excavation from Shenkar to the bifurcation chamber is not currently critical. The PMC is forecasting the Contractor will be able to provide access in December 2017 ahead of the TBM-East contract milestone of 19-Jan 2018.

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EMC Issue No.	Title	EMC Conclusion Statement	PMC Comments
16	Operations Control Centers	We accept NTA's answer about the rescheduling of the TAMACC – it should be reflected in the new master schedule. We do not agree the answer regarding use of secondary OCC as primary one since it does not allow acceptable redundancy as required for a SIL4 system.	<p>The Red Line operations can be performed from two locations:</p> <ol style="list-style-type: none"> 1- Main OCC (TAMACC) 2- Secondary SCC (Depot) <p>SDAG tender documents are being revised to include the following:</p> <p><u>SIL Requirements</u></p> <ol style="list-style-type: none"> 1. The Safety Integrity Level (SIL) expresses the level of confidence that the achievement of the safety requirement is not corrupted by failure mechanisms. 2. During the apportionment of system requirements of RAMS requirements the Contractor shall apportion the designated sub-systems and/or components. This activity shall include assigning safety integrity requirements to the safety critical and safety-related functions, and through the V&V process providing proof of fulfilling the requirements. 3. Safety Integrity Levels (SIL) shall be assigned in accordance with processes defined in EN50126. Typically sub systems and components where the failures result in safety critical outcomes shall be designated SIL 4. Sub systems and components where the failures are safety related but not critical shall be assigned SIL 2. Sub systems and components where there are no safety critical or safety related failure outcomes may be assigned SIL 0 or no SIL. 4. Having assigned a SIL to a sub system or component the associated design processes for that SIL shall be applied in accordance with EN50126. SIL assessment shall be conducted by the Contractor for all functions. Analysis of the SIL assessment against the SIL requirements specified in this document shall be made by Contractor and SIL requirements increased as necessary (e.g., SIL 2 equipment becomes SIL 3 or 4) to ensure the supplied functions are implemented at a SIL level commensurate with their assessed safety requirements.