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Preparation Support for Lelystad Airport Consultation

Report for LVNL

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Document information

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Executive summary

At the request of the Ministry of Transport (MoT), and in close co-operation with CLSK, LVNL commissioned Helios to assist in preparations for the forthcoming Lelystad Airport airspace consultation process.

The scope of the work was to provide:

- A summary of the previous related activities carried out by Helios for LVNL to February 2017;
- A second opinion on the proposed connecting-route-set for Lelystad airport and the design process that led to the design;
- A critical review of the selected route-set and resulting airspace changes as a whole, paying particular attention to:
  - The situation of parachute jumping at Teuge airport;
  - The glider area around Lemelerveld including the north-south transit route for gliders.
- A review of the Lelystad TMA design and the resulting altitudes flown on the proposed Conops B+ inbound and outbound routes;
- A review the KNVvL (Royal Netherlands Association for General Aviation) produced options report.

Summary of previous activities

Helios was previously contracted in late 2016 by LVNL to provide an independent review of the project plan to introduce ATC services at Lelystad Airport and the proposed routes.

The review of the project looked specifically at the schedule to determine if the revised planning towards an April 2019 operational date was achievable, realistic and resilient. We concluded that the planning was generally sound and the planned operational date was achievable and realistic. However, we noted several significant risks with ‘medium’ probability that when combined, presented a higher level of risk to the overall schedule.

We also provided an initial assessment of all 25 route options proposed by LVNL and CLSK. We noted challenges with all the routes, this was because of the constraints of the current airspace. We concluded that, subject to the results of planned development simulations, there was likely to be a combination of routes that could be implemented; however, we noted that the maximum likely capacity of the routes was 7000-10.000 movements per year, and that it would not be possible to achieve the target of 45,000 movements without a more comprehensive future airspace design.

Summary of the recent second opinion

In July 2017, we were contracted to provide a second opinion of the down-selected route set following the planned simulations. Overall, we are satisfied that the proposed route-set will enable the start of operations at Lelystad in 2019. The process adopted by LVNL and CLSK to design, assess and down-select the most acceptable route-set from an operational perspective is generally consistent with best practice, although might not have fully considered the impact on all other airspace users. We also understand that airspace design and associated procedures are intended to be tested during a forthcoming validation simulation, this again is accepted best practice prior to implementation.

In terms of the down-selected routes. We are content that within the constraints of the existing airspace and the ‘given’ design of the Lelystad airport arrival and departure routes (Conops B+), the selected routes appear to be the most suitable from those proposed by LVNL to enable the start of operations at Lelystad in 2019 whilst having least impact on Schiphol and military air traffic operations.

However, there remain consequences for other airspace users which the design of procedures has not, as yet, fully resolved.

The design of the Lelystad airport TMA design is also consistent with the EUROCONTROL General Principles of Terminal Airspace design. The resulting volume of TMA airspace is sufficient to contain the conceptual flight routes, which in turn appear feasible in terms of anticipated compliance with (PANS OPS) procedure design gradients. However, we noted that the base level of the TMA in the region of the IAFs (Initial Approach Fixes) at 2,500ft seems unnecessarily low as the requirement for Lelystad inbounds is to maintain a minimum of FL060 and to descend to 3,000ft 'as late as possible'.

The proposed routes and resulting airspace changes will have an impact on some other airspace users, notably Teuge Airport and the Lemelerveld gliding site. This was also noted in the options report prepared by KNVvL.

The position of the Lelystad airport TMA southern exit point results in the proposed connecting route impacting operations at Teuge. If the route cannot be modified, then the only short-term solution will be to develop new procedures to tactically separate traffic on the proposed route and the para dropping aircraft. The proposed design of the Lelystad airport TMA also creates a restriction to operations at Lemelerveld, this could be mitigated in part by raising the base of the Eastern part of the Lelystad airport TMA to FL045, this has been recently proposed by LVNL.

Using input from our review and proposals from stakeholders, we have proposed four potential options to address some of the identified challenges. We have undertaken a qualitative assessment of each, including whether they could be implemented in the short term (by April 2019) or in the longer term as part of a more comprehensive airspace design. The results are summarised in the table below.

Our assessment indicates that, whilst all the options could deliver potential benefits, none of the options, except Option 3, are entirely positive. All options will require a more detailed operational assessment, including the likely timeframe for their implementation. The decision to implement one or more of the options should consider the impact on all stakeholders and balance their needs with the requirements of the project as a whole.

	Option 1 Positive control of para drop aircraft	Option 2 ARTIP minimum stack FL080, EHLE inbounds IAF South FL070, South-eastern EHLE TMA base raised to FL055.	Option 3 Raising Eastern portion of Lelystad TMA base level to FL045	Option 4 Schedule deconfliction between EHLE Departures and Sector 2 peaks, to enable OUTB-04
Operational feasibility	TBD	TBD	√	TBD
Compatible with the constraints as set by the Alders-process	√	TBD	√	√
Compatible with Conops B+ profiles (lateral and vertical)	√	√	√	√
Environmental effect, especially introduction of new areas that are overflown	0	0	0	0
Impact on controller workload compared to the current design	-	TBD	0	-
Impact on complexity in the current ATM Concept compared to current design	-	TBD	0	-
Impact on Schiphol operations: TMA capacity, ACC sector capacity, sustainability	TBD	TBD	0	0
Impact on military operations	-	0	0	-
Impact on GA-stakeholders: Teuge para dropping Gliding, including Lemelerveld	 ++ 0	 0 +	 0 ++	 ++ 0
Feasibility to incorporate in current design while maintaining current planning with delivery April 2019	TBD	TBD	√	√

	Option 1 Positive control of para drop aircraft	Option 2 ARTIP minimum stack FL080, EHLE inbounds IAF South FL070, South-eastern EHLE TMA base raised to FL055.	Option 3 Raising Eastern portion of Lelystad TMA base level to FL045	Option 4 Schedule deconfliction between EHLE Departures and Sector 2 peaks, to enable OUTB-04
Potential to incorporate in expected (longer-term) future national airspace redesign	X	$\surd$	$\surd$	X
Notes:	Increase in workload for military ATCOs working para drop aircraft, this would be in addition to increased workload resulting from having to tactically separate military traffic in TRA 12 and TRA Wamel from Lelystad traffic. Any effect on workload of civil ATCOs TBD. We expect that this could only accommodate limited Lelystad movements in the short-term. Portion of route going through segregated airspace would have to be established as CDR1 and annotated as permanently plannable.	A technical assessment of this option would need to consider the impact on the TMA operations as a whole. One of the key issues to address would be the descent profile for inbounds after leaving ARTIP; in particular, to Runway 27. Implementing this option could increase complexity of Lelystad project.	Raising base level from 2500ft would allow increased access for civil/military VFR/transit traffic below Controlled Airspace without the requirement for ATC clearance (i.e. in Class E airspace).	Operator acceptability and sustainability of schedule deconfliction at EHLE is questionable. Small increase in workload on ACC controller is expected, but this will not impact capacity. Short-term solution only; would not form part of future airspace re-design

Our assessment was based on expert judgement and expressed using the following indicators:

Indicator	Description
++	Strong positive effect
+	Positive effect
0	No effect
-	Negative effect
- -	Strong negative effect
TBD	To be Determined – insufficient data available
√	Yes
X	No or Unlikely

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1 Introduction

1.1 Background

In order to both accommodate the forecast continued growth in air traffic at Schiphol airport, and to address the concomitant environmental impact, the Dutch Government proposed to develop Lelystad Airport. It is intended to open Lelystad to commercial traffic from April 2019.

In addition to upgrading the airport ground infrastructure it is necessary to establish controlled airspace (a Terminal Manoeuvring Area or TMA) in the vicinity of Lelystad Airport and to create a set of inbound and outbound flight routes within the TMA linking the runways to the predetermined TMA exit and exit points. The Dutch Government commissioned To70 to develop these routes and a route-set known as the Conops B+ was selected and agreed upon in the Alderstafeloverleg process during 2014.

Since then, LVNL and CLSK have been developing connecting routes to the wider ATS route network and the associated airspace changes. The proposals are now being finalised and will be subject to consultation starting in September 2017.

1.2 Scope

At the request of the Ministry of Transport (MoT), and in close co-operation with CLSK, LVNL commissioned Helios to assist in preparations for the forthcoming Lelystad Airport airspace consultation process.

Specifically, we have been asked to provide:

- A summary of the previous related activities carried out by Helios for LVNL to February 2017;
- A second opinion on the proposed connecting-route-set for Lelystad airport and the design process that led to the design;
- A critical review of the selected route-set and resulting airspace changes as a whole, paying particular attention to:
  - The situation of parachute jumping at Teuge airport;
  - The glider area around Lemelerveld including the north-south transit route for gliders.
- A review of the Lelystad TMA design and the resulting altitudes flown on the proposed Conops B+ inbound and outbound routes;
- A review the KNVvL (Royal Netherlands Association for General Aviation) produced options report, and to look at specific options that can be of use within the timeframe to start operations at Lelystad Airport (April 2019).

1.3 Approach

This report builds on a previous study in which we were asked to provide a second opinion on the route options proposed by LVNL. Our analysis and findings are based on our understanding of relevant international best practice; current arrangements in the Netherlands, specifically the Netherlands airspace and ATM operations; provided documentation and interviews with identified stakeholders. The work has been conducted independently of MoT, LVNL and CLSK.

Whilst related, our approach to each element of the report is necessarily different; however, because of time constraints, all elements of the work were conducted in parallel.

1.4 Structure of this report

This report is structured as follows:

- In Section 2 we provide a brief summary of related activities carried out by Helios for LVNL to February 2017;
- In Section 3 we provide a second opinion on the proposed connecting route-set for Lelystad airport and the design process that led to this design;
- In Section 4 we examine the impact of the selected route-set and resulting airspace changes on Teuge and Lemelerveld;
- In Section 5 we consider the design of the Lelystad TMA; and
- In Section 6 we address relevant comments from a report produced by KNVvL;
- In Section 7 we consider the potential of options arising.

2 Summary of related activities carried out by Helios

2.1 Overview

Helios was contracted by LVNL to provide an independent review of the project plan to introduce ATC services at Lelystad Airport and the proposed routes. The study addressed these two distinct areas:

- A review of the LVNL project to introduce ATC services at Lelystad Airport;
- An independent review of proposed routes document provides independent opinion on the connecting routes.

The work was undertaken in late 2016 and early 2017. Our reports were finalised in February 2017.

2.1 Review of the LVNL's project

2.1.1 Scope

The review of the project to introduce ATC services at Lelystad Airport was based on a request to look specifically at the schedule, and determine if the revised planning towards an April 2019 operational date was achievable, realistic and resilient.

The review examined the project from the perspective of functional planning, future risks and dependencies, and the underlying change control processes.

2.1.2 Key findings

Our opinion was that the planned operational date was achievable and realistic.

We concluded that the planning was generally sound and that the project schedule appeared reasonable. We also noted that the recent decision to delay implementation to April 2019 had resulted in some significant buffers. This would help absorb unplanned events and would allow for some delay to the agreement of the operational concept (connecting routes and airspace design), enabling all stakeholders to make an informed and robust decision on these matters.

We did, however, note several significant risks with 'medium' probability. We considered that when combined, there was a higher level of risk to the overall schedule. Given the number, we determined that it was likely that one of them would probably occur in such a manner as to disrupt the critical path.

We identified the most likely risks as:

- The success criteria changing during the project's lifetime, including not being comprehensive enough to drive valid project requirements;
- An agreement on the operational concept which alters through the project lifecycle; each connecting route is tightly designed and has drawbacks; therefore, all civil and military airspace users, Lelystad and Schiphol Airports, civil and military controllers, Ministry and regulatory stakeholders must agree with the trade-offs in choosing the eventual routes;
- The risk of re-work to the operational concept as a result of public consultation, even recognising the schedule anticipated by LVNL and the Ministry;

- A change to the agreed constraints on the project, for example the requirement for no negative impact on Schiphol traffic changing due to the route design, and the resultant time and coordination to agree the changed constraint;
- The possible delay in recruitment and training of civil TWR controllers, in finding an appropriate controller pool with the skills required for the mix of IFR and VFR traffic, and the potential delay in assigning and training CAPP controllers (military), in both cases ensuring the simulation facilities are ready on-time;
- The proposed operational date of April 2019 relied on a single major release of AAA Lelystad CAPP and TWR software following the civil-military co-location AAA build. Repair builds are foreseen, but any issues with the software requiring a rectification build may possibly impact the critical path and operational date. LVNL should explore adding margin to the project plan to take account of these points, particularly in adding resilience to the current schedule.

We did not have full confidence that the mitigations were adequately implemented, resourced and tracked. Therefore, we provided a number of recommendations that would increase confidence in the planned operational date. Our recommendations were:

- At the earliest opportunity, finalise the operational concept based on capacity planning with Lelystad Airport and the key airlines;
- In all aspects of AAA development, explore adding more margin including potentially planning for a second rectification build of AAA CAPP (co-location) and/or a single rectification build of AAA Lelystad CAPP and TWR;
- Develop risk scenarios to understand the potential impact of individual or combined risks on the operational date;
- Develop and agree more detailed mitigation plans for key risks;
- Develop a clear dependency log, assessing all potential interdependencies (input and output) and identifying key tracking metrics to understand the impact of changes in scope or timelines;
- Identify the assumptions under which the implementation date can be met and communicate these with all stakeholders.

2.2 Independent review of proposed routes

2.2.1 Scope

The independent review of the proposed routes was requested to provide an independent opinion on the connecting routes from the terminal airspace to the ATS route network.

The work included an assessment of:

- The likely daily traffic amounts possible using the designed connecting routes;
- Whether the information regarding operational and environmental effects of the routes as designed was complete and correct;
- Whether there were any other viable solutions possible for connecting the terminal routes to the existing ATS network;
- The correctness of the design, assumed by the review team to be consistent with best practice and, in particular, PANS-OPS; and

- The alignment of the routes to the Dutch ATM concept.

2.2.2 Key findings

We assessed all 25 route options to connect the Bravo+ arrival and departure routes for Lelystad Airport to the ATS route network individually. We noted challenges with all the routes, this was because of the constraints of the current airspace and the difficulty of 'inserting' new routes into airspace that was designed to predominantly serve Schiphol and support the current level of military operations.

We discussed the proposed routes with LVNL and CLSK. We noted that the design of the routes was constrained by a number of pre-requisites. Some of the pre-requisites were not particularly well defined, this resulted in artificial constraints that forced specific design solutions. To overcome this, the design team had attempted to create alternative profiles that did not meet all of the pre-requisites. We considered that there was a risk that these might not be acceptable.

Our assessment was undertaken before the results of the workload modelling and prior to the planned real-time simulations (RTS). The RTS had been planned and was being prepared as our report was finalised, it was intended that together with the output from the workload modelling, the RTS would enable LVNL and CLSK to down-select the most suitable routes. We assessed the workload modelling techniques as appropriate for the task at hand and in accordance with current standards.

We concluded that, subject to the outcome of the RTS, there was likely to be a combination of routes that could be implemented to allow operations to commence at Lelystad airport in April 2019. However, we noted that the maximum likely capacity of the routes was 7000-10.000 movements per year, and that it would not be possible to achieve the target of 45,000 movements without a more comprehensive future airspace design.

We also concluded that LVNL had adopted best practice in the design of the routes and, despite the constraints, had designed the routes to best fit with the current airspace concept.

3 A second opinion on the proposed connecting route-set for Lelystad airport and the design process that led to this design

3.1 Scope

We had previously undertaken a review of the design process and proposed route-set for Lelystad airport. Since undertaking our previous review, LVNL and CLSK have continued to assess and further refine the route-set to identify the most suitable routes.

The scope of this task is to provide a second opinion of the down-selected route-set, including any proposed changes to the routes made as a result of the down-selection process and the approach taken to down-select the proposed routes.

3.2 Design process

We previously reviewed the design process. The scope of this review was therefore limited to the Real Time Simulation (RTS) activities and the process then used by stakeholders to down-select the routes.

3.2.1 RTS

The RTS was conducted in the AAA-Simulator at LVNL Schiphol East facility. Two simulations were conducted per day covering the 25 route options.

As is standard practice with such a design activity, this was a ‘development simulation’ from which a number of scenarios are tested as close to real-life environment as possible. Judgement is necessarily largely subjective and qualitative based upon operational expertise. The controllers making the final judgement were selected experts in the fields of procedures, human factors, safety and capacity.

To assist their judgement the controllers had the following supporting information available:

- A workload impact assessment by LVNL;
- A workload impact assessment by CLSK;
- A second opinion of the full route-set as previously provided by Helios;
- A qualitative assessment from a procedures perspective (LVNL only);
- A qualitative assessment from an efficiency perspective (LVNL only);
- A qualitative assessment from a safety perspective (LVNL only);
- A qualitative assessment from a human factors perspective (LVNL only);
- A qualitative assessment from a vision and strategy perspective (LVNL only).

The simulation was performed to test operational acceptability to LVNL and CLSK of the pre-designed connecting route-set through qualitative analysis. The simulations did not specifically consider the impact on other airspace users.

3.2.2 Down-selection of routes

The down-selection of the routes was undertaken by an operational review team comprising representatives from LVNL and CLSK TMA, ACC (Area Control Centre), APP (Approach) and TWR controllers.

All potential routes were analysed using output from the RTS. Acceptance or rejection of each route was based upon detailed discussions and qualitative judgement.

The outcome of the down-selection resulted in two route concepts; Route concept A, and B:

- Route concept A assumes NM (Nieuw-Milligen) TMA A in the North was not active, therefore containing a CDR to keep Lelystad airport traffic to/from Sectors 4 and 5 North of the Schiphol airport TMA;
- Route concept B assumes NM TMA A is active, thus alignment of those routes is adjusted to fly within or above the Schiphol airport TMA.

These are illustrated in Figure 1 and Figure 2 below.

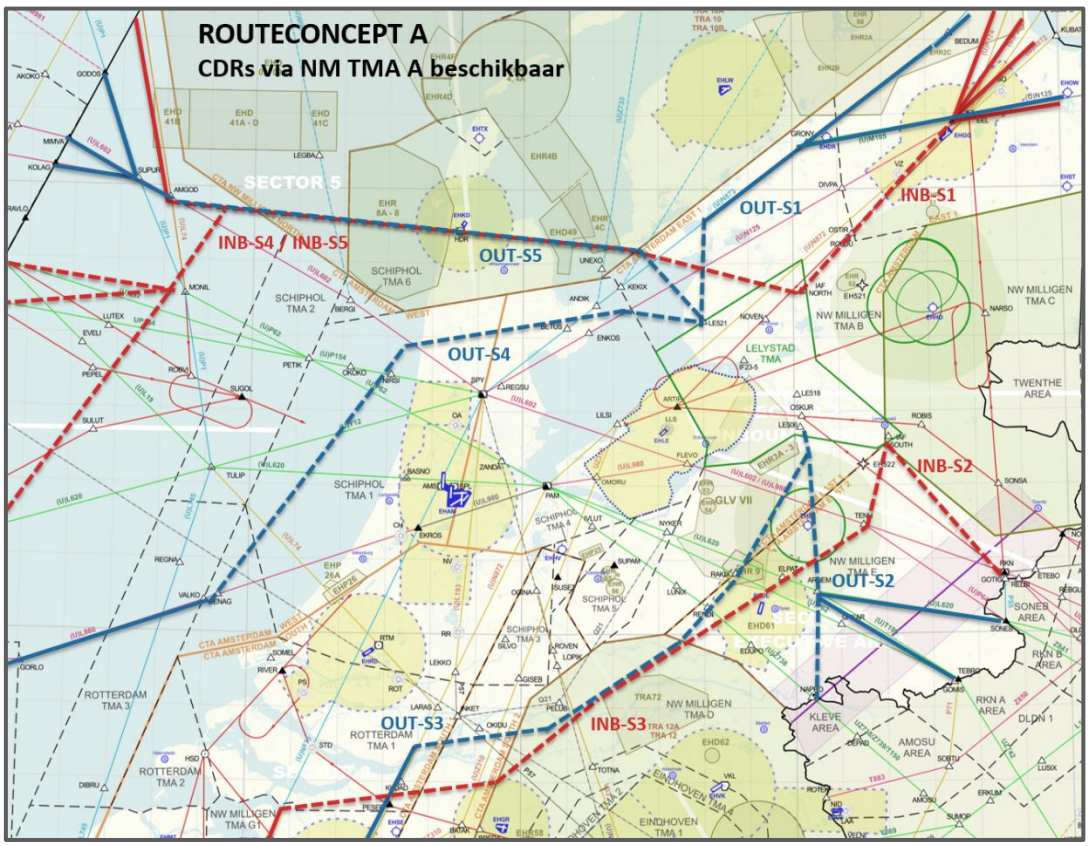

Figure 1: Route concept A connecting routes (NM TMA A available)

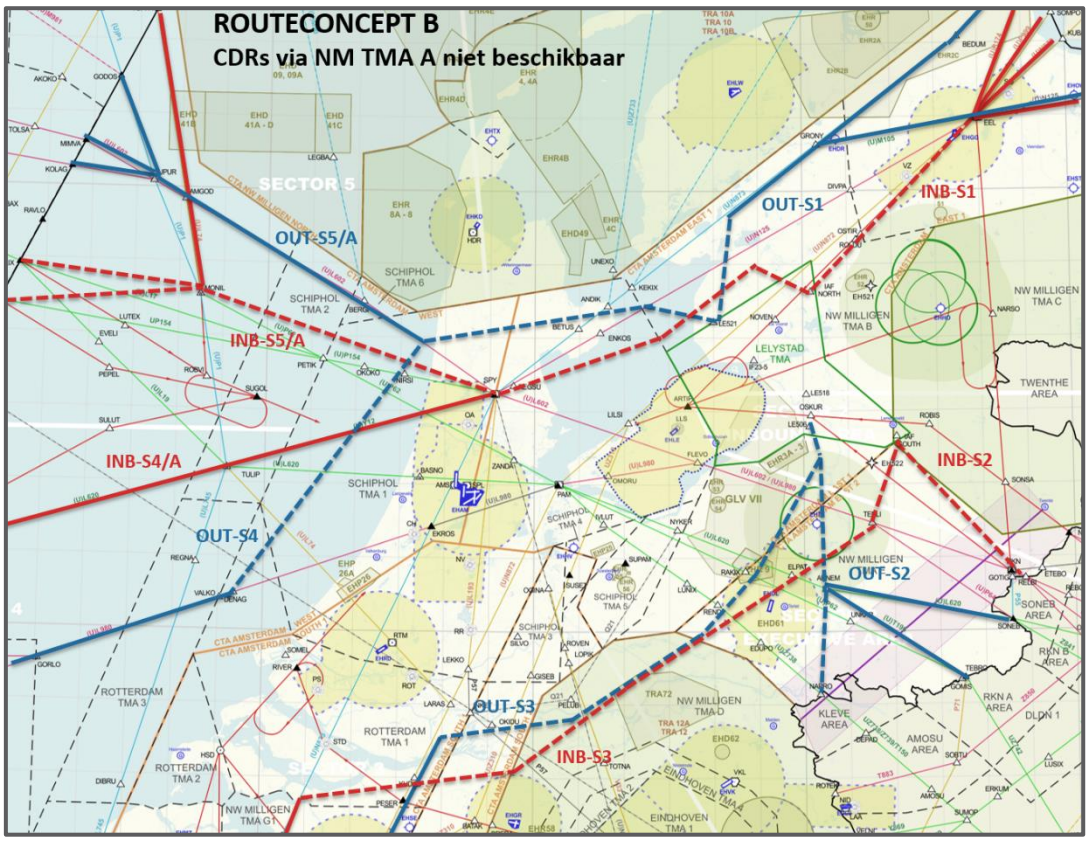

Figure 2: Route concept B connecting routes (NM TMA A not available)

Note: Each ACC sector now comprises one inbound and one outbound route for Lelystad airport, plus an additional CDR which serves Sectors 4 and 5 and allows the TRAs (Temporary Reserved Area) to the north to be crossed if inactive. The final route designators reflect the destination sector e.g. OUT-S4 = the outbound route from Lelystad ending in ACC Sector 4.

The proposed routes were recorded in the Conops ATS-routes Lelystad airport 2019 document[1].

3.3 Review of down-selected routes

We have reviewed the outcomes of the RTS and analysis to determine the suitability of the down-selected routes.

Our understanding of the key findings and outcomes are summarised in Table 1.

[1] Aansluiting luchthaven Lelystad op het ATS-routenetwerk in 2019. Dated 28 June 2017

Sector	Route	Status	Comment
1	INB-01	Accepted	**New designator**: INB-S1
	OUTB-01	Accepted	**New designator**: OUT-S1
2	INB-02	Accepted	**New designator**: INB-S2
	INB-03	Rejected	Non-compliant with Lelystad airport Conops B+, in conflict with Lelystad airport departures.
	OUTB-02	Accepted	Deemed operationally acceptable, on the provision that parachute jumping activities at Teuge airport do not hinder the Lelystad airport traffic. This is commented upon further in Section 3 below. **New designator**: OUT-S2.
	OUTB-03	Rejected	Non-compliant with Lelystad airport Conops B+ due to exit fix west of EHR3.
	OUTB-04	Rejected	Potential conflicts in height with a high-performance Lelystad airport departure being constrained by slow climbing Schiphol airport departure(s). Almost opposite direction tracks which exacerbate the above and create high workload for Sector 2 in turning to the south-east and at the same time separating from Teuge airport parachute dropping aircraft. Complex vectoring to establish a track separated from Schiphol airport departures, Dusseldorf arrivals/departures etc, in order to climb the Lelystad airport departure and comply with exit level restrictions. Unacceptable traffic presentation and therefore workload to Sector 2
3	INB-04	Rejected	Conflict between descending Lelystad airport inbounds on the same route as climbing EHAM departures (N873), creating additional workload on Sector 3 and Sector 1 as well as higher complexity for the ACOD manager.
	INB-05	Rejected	Low level through Schiphol TMA; conflicts with EHAM in and outbound traffic and Lelystad airport departures.
	INB-06	Accepted	Route passes through NM TMA D/TRA12. Subsequent small re-alignment to avoid recent new TRA72 which is embedded within NM TMA D. **New designator**: INB-S3.

Sector	Route	Status	Comment
	INB-07	Rejected	Without reduced coordination – i.e. during military flying periods: not feasible when TRA12 and EHR1 are active. However, with Reduced Coordination the route proved not feasible due to the number of conflicts creating excess workload on Sector 2 and Sector 3.
	OUTB-05	Rejected	Required climb above Schiphol TMA but an available level cannot be guaranteed by ACC; non-compliant with Conops B+ exit fix.
	OUTB-06	Rejected	Low level through Schiphol TMA conflicts with EHAM in and outbound traffic.
	OUTB-07	Accepted	Passes through NM TMA D/TRA12. Since original design some small re-alignments have been made to avoid the recently adopted TRA72 embedded within NM TMA D. We understand a further amendment is proposed to avoid EHR/09, which would result in this route initially being aligned as OUT-02 before turning to the South-West. **New designator**: OUT-S3.
	OUTB-08	Rejected	Without reduced coordination: not feasible when TRA12 and EHR1 are active. With reduced coordination: not feasible due to the number of conflicts in e.g. Eindhoven area. Excess workload on Sector 2 and Sector 3.
4	INB-09	Rejected	Low level through Schiphol TMA; conflicts with EHAM in and outbound traffic.
	INB-08	Conditionally Accepted	Route stays above Schiphol TMA but will only be flown if the CDR based on INB-11 is not available (see below). Subsequent small re-alignments have been made beyond SPY to avoid N873 (route is positioned 7 NM south of N873). **New designator**: INB-S4/A (when either EHR8 or EHD49 are active).
	INB-11	Conditionally Accepted	CDR due to EHR8 and EHD49. If this CDR is available, it must be flown instead of INB-08. **New designator**: INB-S4 (CDR, when both EHR8 and EHD49 are **not** active).
	OUTB-09	Rejected	Required climb above Schiphol TMA but an available level cannot be guaranteed by ACC; non-compliant with Conops B+ exit fix.

Sector	Route	Status	Comment
	OUTB-10	Conditionally Accepted	Routes through the Schiphol TMA but re-aligned to route closer to the southern edge of NM TMA A, while avoiding the hold protection area around SUGOL; will be climbed tactically. Conditions: minimum climb performance, and a Requested Flight Level above FL135. **New designator**: OUT-S4.
5	INB-10	Conditionally Accepted	Stays above Schiphol TMA. Route can be flown only if CDR based on INB-11 is not available. Subsequent small re-alignments have been made beyond SPY to avoid N873 (route is positioned 7 NM south of N873). **New designator**: INB-S5/A (when either EHR8 or EHD49 are active).
	INB-11	Conditionally Accepted	FIR entry Sector 5, then CDR due to EHR8 and EHD49. If this CDR is available, it must be flown instead of INB-10. **New designator**: INB-S5 (CDR, when both EHR8 and EHD49 are **not** active).
	INB-12	Rejected	Low level through Schiphol TMA; conflicts with EHAM in and outbound traffic.
	OUTB-11	Rejected	Required climb above Schiphol TMA but an available level cannot be guaranteed by ACC; non-compliant with Conops B+ exit fix.
	OUTB-12	Accepted	CDR due to EHR8 and EHD49. If this CDR is available, it must be flown instead of OUTB-13. **New designator**: OUT-S5 (CDR, when both EHR8 and EHD49 are **not** active).
	OUTB-13	Conditionally Accepted	Will be climbed tactically. Conditions: minimum climb performance *tbd* and a Requested Flight Level above FL135. **New designator**: OUT-S5/A (when either EHR8 or EHD49 are active).

Table 1: Outcomes of route down-selection

We understand that the intention is for the CDR for INB-S4, INB-S5 and OUT-S5 to be flight-planned whenever it is available. If the route was to become available through Airspace Management negotiations outside of the ‘usual’ night and weekend timings this may require additional intervention though IFPS (Initial Flight Plan Processing System) or AUP (Airspace Use Plan) /CRAM (Conditional Route Availability Message) processes.

We also noted that project pre-requisites were originally defined to protect the “network quality” of Schiphol and restrict Lelystad airport traffic from flying through (or immediately above, which corresponds to a height of up to FL130) the Schiphol airport TMA. This presented a potentially difficult constraint (particularly with respect to Lelystad airport departures via the Northern exit fix of the Conops B+ design, which would find it

impossible to comply due to the required climb profile). As such, the Procedure Design team presented alternatives which would actually fly through the TMA, but otherwise be compliant with Conops B+. This has been accepted for OUT-S4 and OUT-S5/A which after passing FL060 will be laterally separated from other traffic (e.g. Schiphol inbounds via waypoint ARTIP) and tactically climbed by APP as soon as conditions permit. There will inevitably be an impact on TMA workload, but due to the anticipated small number of Lelystad airport's movements in this direction it has been assessed as workable and is not anticipated to adversely affect capacity within the TMA. A minimum climb performance will be required (value to be determined) to aircraft flight-planning these routes in order to de-conflict from Schiphol airport traffic as soon as possible, and to avoid being kept at low level for an extended period.

3.4 Our observations

Overall and in our opinion, the proposed route-set will enable the start of operations at Lelystad in 2019.

We are satisfied that the process adopted by LVNL and CLSK to design, assess and down-select the most acceptable route-set from an operational perspective was generally consistent with best practice, although might not have fully considered the impact on all other airspace users.

We understand that airspace design and associated procedures are intended to be tested during a forthcoming validation simulation, this again is accepted best practice prior to implementation.

In terms of the down-selected routes, we are content that within the constraints of the existing airspace and the 'given' design of the Lelystad airport arrival and departure routes (Conops B+), the selected routes appear to be the most suitable from those proposed by LVNL and CLSK to enable the start of operations at Lelystad in 2019 whilst having least impact on Schiphol and military air traffic operations. However, there remain consequences for other airspace users which the design of procedures has not, as yet, fully resolved.

The addition of a CDR through the EHR-8/ EHD49/TRA10 region is a sensible alternative to reduce impact on the Schiphol airport TMA whenever possible, and correlates well with developing FUA (Flexible Use of Airspace) in the Netherlands; provided the necessary Airspace Management processes are enabled.

We are also satisfied that ATS provision has also been properly considered, forming the basis for detailed definition of procedures to be further developed and then validated through the planned validation RTS.

4 A review of the selected route-set and resulting airspace changes on Teuge and Lemelerveld

4.1 Scope

In addition to the analysis of the routes in Section 2, we were also asked to undertake a critical review of the selected route-set and resulting airspace changes as a whole and pay particular attention to:

- The situation of (para jumping at) Teuge Airport;
- The glider area around Lemelerveld, including the north-south transit for gliders.

4.2 General analysis of connecting routes and airspace

4.2.1 Connecting routes

The design of the connecting routes and the resulting airspace was constrained by a number of pre-requisites, the most relevant to Teuge and Lemelerveld being:

- The Conops B+ design for the Lelystad airport TMA, SIDs and STARs was predicated upon advice from the Alderstafel Lelystad to ensure minimum noise interference for populated areas and a minimum height of 6,000ft over the 'Old land'. We also understand the resulting route design within the TMA was affected by legal requirements to examine specific noise contour calculations.
- The requirement to not impact Schiphol airport operations in term of 'airline network quality' and military mission effectiveness.

In addition, the upper levels of the Lelystad airport TMA and route definitions are restricted due to Schiphol airport inbound traffic above (via ACC Sector 2). The artillery range EHR/3 provides another design constraint to the south of Lelystad, affecting the positioning of the southern exit fix. EHR/3 is active generally every day up to 3,000ft, but we are advised that EHR/3A is also regularly active up to FL185.

These constraints limited the options available to LVNL and CLSK that would enable Lelystad operations to commence in 2019.

4.2.2 Airspace

The proposed routes inevitably resulting in some airspace changes. From discussing with representatives from the GA community and, specifically, Teuge and Lemelerveld, the majority of current issues involving GA are due either to the physical Conops B+ design (dimensions and airspace classification) or the resulting connecting routes.

We have reviewed the proposed airspace and, whilst accepting that the low-level routes are a given and the surrounding airspace classification is provided as protection to these routes, we note:

- The base level of the Lelystad airport TMA in the region of the IAFs (Initial Approach Fixes) at 2,500ft seems unnecessarily low, when the stated requirement is for inbounds to maintain a minimum of 6,000ft (FL060 in practice) and to descend to 3,000ft 'as late as possible';
- The upper level of the Lelystad airport CTR in the portion delegated from the Schiphol airport TMA restricts the climb of departures from Runway 23, technically requiring

level-off portions at 2,000ft and 3,000ft. This in turn restricts the later climb to 6,000ft (FL060) and has resulted in the current position of the southern exit fix.

The level restriction of 6,000ft (in practice it will be FL060 due to the Transition Altitude in the Netherlands being 3,000ft) for inbound and outbound aircraft results in some Class E airspace being upgraded to Class D. Although both classifications are Controlled Airspace, Class E allows VFR access without radio communication nor requiring a clearance. On the other hand, Class D airspace requires both radio communication and a clearance for all VFR traffic, in order to provide traffic information to commercial IFR flights as well as other VFR traffic. This will result in VFR traffic within the band FL055 to FL065 and within the lateral areas re-designated Class D now requiring an ATC clearance. The amount of GA traffic this may affect is, however, not known to us at this level of assessment.

4.3 Impact on Teuge parachuting operations

The position of the Lelystad airport TMA southern exit point is the result of climb constraints, a fixed artillery range, and efforts to minimise noise. This results in the proposed connecting route potentially impacting operations at Teuge.

The parachute dropping zone is permanently active up to FL095, with regular requests made to jump from FL130. Demand is reported as 130,000 drops per year, activity taking place whenever weather conditions permit, sunrise to sunset, with approx. 70% of the drops being from FL90 with the remainder from FL130.

According to current procedures, we understand AOCS (Air Operations Control Station) NM retain the parachute dropping aircraft on their frequency, in case instruction/restriction is required. Flight above FL095 is subject to ACC approval due to the need to provide separation from Schiphol departures plus other transit aircraft. Practically speaking ACC Sector 2 will normally give a ‘block clearance’ to AOCS NM for the handling of the para-drop aircraft within ACC airspace. The para-drop area, SSR code and maximum level are agreed so the Sector 2 controller is able to keep at least 5 NM/1000ft clear of the aircraft. The para-drop aircraft keeps a listening watch on the AOCS NM frequency.

Three alternatives were considered by LVNL for departures from Lelystad airport through the southern exit fix:

- East of Teuge airport;
- West of Teuge airport; or
- Overhead Teuge airport area (using the proposed OUT-S2).

4.3.1 Routing East of Teuge

Routing to the east was rejected at an early design stage due to Lelystad departures being unable to climb due to westbound traffic, i.e. descending inbounds to Schiphol airport and climbing outbound traffic from the Dusseldorf airport area.

If transfer of communication is to take place free of these conflicting flights, the Sector 2 ACC controller has little space and little time left to sequence the Lelystad airport departure and comply with the agreed transfer levels with Langen ACC, or especially MUAC (Maastricht Upper Area Control). The alternative of transferring a Lelystad airport departure to Langen ACC by AOCS NM at FL090 (or below) was considered unacceptable for Langen ACC due to the busy Dusseldorf Departure North sectors.

4.3.2 Routing West of Teuge Airport

The original route OUTB-04 (to the West of Teuge airport) was rejected for operational reasons described in Section 2.

Negotiations between LVNL and CLSK to design a route from the proposed Lelystad airport TMA exit point (LE506) to avoid the existing parachute dropping area have not managed to reach an acceptable operational compromise at the time of writing. We have not been advised of any alternative proposals and therefore are unable to comment further on this.

Since the reasons for rejection of OUTB-04 were predominately based upon workload, the potential to mitigate some of the operational concerns in the short-term may exist by managing the timing of Lelystad departures to avoid periods of heavy Schiphol airport departure traffic in Sector 2. However, this would need further examination by the LVNL and CLSK experts.

4.3.3 Routing overhead Teuge (OUT-S2)

Based upon the scenario of OUTB-02 being the only currently feasible route from an ATM perspective which accords with Conops B+ (now OUT-S2), we analysed route OUT-S2 in more detail to understand whether an acceptable way could be found of operating it with regard to para jumping operations.

A view expressed to us by LVNL ACC experts is that an acceptable solution may be found by positive control being provided to the para-drop aircraft by ATC with specific procedures developed for (a) operations up to FL095; and (b) above FL095 up to FL130. If a solution could be found, separation could be achieved between Lelystad departures and the para-drop aircraft by tactical instructions; with the aim of minimising climb restrictions for the Lelystad airport traffic as it transits the area. We are advised that a similar procedure is used successfully at Rotterdam airport.

We note that the portion of the route going through segregated airspace would have to be established as CDR1 and annotated as permanently plannable. Careful construction and validation of procedures would also be required and from a safety perspective it would be preferable for the para drop aircraft and transiting Lelystad airport traffic to be on the same frequency. CLSK experts expressed concern about the resulting additional workload for military ATCOs, as this would be in addition to increased workload resulting from having to tactically separate military traffic in TRA 12 and TRA Wamel from Lelystad traffic.

4.4 Impact on Lemelerveld glider operations

The current design of the Lelystad airport TMA creates a restriction to operations at Lemelerveld. Proposals to mitigate by raising the base level of the TMA has been put forward, but they still result in operational disadvantage to Lemelerveld.

The key issues potentially affecting operations at Lemelerveld are the design and classification of the Lelystad TMA (Conops B+), the ATS connecting routes plus the surrounding airspace volumes mentioned above (between FL055 and FL065) for entry to the TMA. All traffic will be Class D, being more restrictive than the current Class E for GA operations.

The Conops B+ design results in Class D airspace from 2,500ft to FL065. However, a recent proposal from LVNL (we understand under consideration) is to raise the base of the Eastern part of the Lelystad airport TMA to FL045; we understand this portion would be to the East and North-east of approximately the position of waypoint LE510. This would allow

descent to FL050 for Lelystad traffic after passing IAF South (or North), but would also offer a higher level below Controlled Airspace for VFR traffic to operate without the requirement for ATC clearance (i.e. in Class E airspace). This would reduce the proposed restriction on Lemelerveld operations as well as provide more access below controlled airspace to GA traffic transiting North-South in that region.

Waypoint LE510 is approximately 20 NM from touchdown for Runway 23, which would equate to 6,000ft on a CDA. At times of high atmospheric pressure, FL060 (the initial approach level) would be higher than 6,000ft, therefore the flexibility to descend to below FL060 at some point before LE510 will be operationally necessary.

The current design proposal is based upon Schiphol airport inbounds continuing as present with minimum stack level FL070 at waypoint ARTIP. This has resulted in Lelystad airport arrivals being restricted to maximum FL060 at IAF South and IAF North. The distance to touchdown from IAF South in particular (approx. 37 NMs for Runway 23, following the RNAV transition) would in practice lend itself to a higher initial approach level than FL060.

If FL045 was unacceptable for Lemelerveld operations, a possibility of raising all levels further (by 1,000ft) could be a logical candidate for assessment. Information provided to us regarding glider flight logging in the Netherlands indicates that cross country flights regularly achieve between 5,000 and 5,500ft.

Lelystad airport inbounds at FL070 via IAF South would mean raising Schiphol inbounds via ARTIP to FL080. Note; ARTIP hold and the hold at IAF South are laterally separated at FL070, although traffic leaving IAF South heads towards waypoint ARTIP therefore holding at the same level would not be recommended practice.

The key issue to address regarding Schiphol operations would be the descent profile for inbounds after leaving ARTIP; in particular, to Runway 27. It is evident that when sequencing through waypoint ARTIP it is frequently a challenge for ACC to descend the traffic low enough for an acceptable transition to APP whilst they also have to reduce speed. Merging from several different directions adds to the challenge, so this task must not be made any more difficult or inefficiencies of (for instance) extended vectoring may result.

Any consideration or development of the above suggestion must therefore be conducted by LVNL and CLSK.

4.5 Our observations

The design of the airspace surrounding Lelystad airport has been constrained by avoiding any adverse impact upon Schiphol airport capacity and network quality, in addition to considering existing infrastructure, such as that of other airspace activities. The Conops B+ design, which was the result, appears to have satisfied those constraints but also creates potential adverse effects upon other airspace users, specifically those operating from Teuge and Lemelerveld.

The impact on Teuge airport is exacerbated by the position of the Lelystad airport TMA southern exit point as a result of climb constraints, a fixed artillery range, and efforts to minimise noise. As such, it has not been possible to design a route that avoids para jumping area. If a solution to the route cannot be found, then the only credible option appears to be to develop transit procedures for the Teuge airport area based on the para

dropping aircraft being under positive control. This is likely to increase controller workload and, as such, would only be suitable for a limited number of Lelystad movements.

At Lemelerveld, the current design of the Lelystad airport TMA restricts an established operation. Proposals to mitigate by raising the base level of the TMA has been put forward, but they still result in some operational disadvantage to Lemelerveld. A potential compromise, subject to assessing the operational impact on Schiphol airport, could be raising minimum stack level at waypoint ARTIP to FL080 to further raise the South-eastern portion of the TMA (e.g. to FL055).

5 A review of the Lelystad TMA design and the resulting altitudes flown on the proposed inbound and outbound routes

5.1 Overview

In order to begin to review the appropriateness of an airspace structure it is useful to consider the fundamentals of Terminal Airspace design.

The EUROCONTROL Manual for Airspace Planning[2] lists six General Principles as the cornerstones of the Terminal Airspace design process. Of these principles, only Principle 1 (and its sub-principle) is prescriptive in that it stems from an ICAO Standard contained in Annex 11 (complemented by provisions in PANS-ATM Doc. 4444).

These General Principles are listed below:

- P1: Safety shall be enhanced or at least maintained by the design of (or alteration to) a Terminal Airspace; this Principle includes a recommendation to comply with ICAO Standards, Recommended Practices and procedures);
- P2: Terminal Airspace design should be driven by operational requirements;
- P3: Without prejudice to P1, whether and to what extent consideration shall be given to environmental impact when designing a Terminal Airspace is to be decided by State policy;
- P4: The design of a Terminal Airspace should be done in a collaborative manner;
- P5: Terminal Airspace should be designed, where possible, so as to be integrated into the airspace continuum both vertically and laterally without being constrained by State boundaries;
- P6: Terminal Airspace design should be designed following a clear design methodology within the context of Terminal Airspace Design.

In order to review the design of the Lelystad airport TMA it is useful to consider the proposal against these general principles of airspace design. The following paragraphs consider the development of the Lelystad TMA against each Principle in turn.

5.2 Principle 1: Safety

It is a fundamental premise that the design of Terminal Airspace should ensure, be conducive to and supportive of safe operations within the airspace. Furthermore, ICAO Annex 11 requires any design (or modification) of any aspect of an airspace to be subjected to a safety assessment.

The requirement for a safety assessment calls for analysis, evaluation and validation of any airspace design and suggests that a qualitative analysis and evaluation be undertaken before quantitative analysis, evaluation and validation.

The reason for recommending this sequence of analysis is that a qualitative analysis and evaluation of an airspace refers to the process whereby it is determined to what extent the airspace designed meets international standards, recommended practices and Terminal Airspace design guidelines. Practically, the qualitative assessment phase may be described as one of conceptual development where inconsistencies are detected and sub-

[2] Volume 2 – Section 5 Terminal Airspace Design Guidelines - Part A

optimal elements of the design are discarded. Indeed, a thorough qualitive assessment may reduce the required scope of any quantitative assessment, normally undertaken by simulation (real-time or fast-time). A sound qualitative analysis and evaluation ensures that potential candidate designs can be thoroughly analysed and evaluated at the quantitative phase.

Evidently, the design development of the Lelystad airport TMA did follow this design Principle in so far as both qualitive and quantitative assessments were undertaken, and in that order. An initial collection of approximately 25 candidate routes were developed and these were subsequently subject to individual qualitive assessment. The result was the down-select of approximately a dozen routes (referred to as the Conops B+ routes) that were then subject to further quantitative assessment using real time simulation and evaluation. The simulation exercise was conducted over the period 27-28th March 2017 and is described in a related information bulletin[3].

5.3 Principle 2: Design to be driven by operational requirement

This Principle requires that the airspace conceptual development precedes the (PANS-OPS) design stage. Indeed, sub-optimal design often results from the practice whereby route placement within Terminal Airspace is driven exclusively by (PANS OPS) design criteria as opposed to ATM efficiency.

It would appear that the conceptual design of the Lelystad airport TMA was developed and refined ahead of any detailed consideration of PANS OPS design criteria. The development of these route designs was clearly seeking to accommodate both current and future operational requirements. These routes were then subject to individual qualitive assessment by a team of operational specialists. Consequently, it seems clear that the 2nd General Principle was observed during the development of the Lelystad airport TMA design.

5.4 Principle 3: Consideration of environmental impact

This Principle seeks to address the increasing challenge being presented to ATC and/or Airport Operators to minimise adverse environmental impact. The Principle acknowledges that the extent to which environmental considerations are accommodated, if at all, during airspace development is a matter for the State to determine.

The Dutch Government commissioned the development of a number of candidate route designs to serve Lelystad Airport. In 2014, the Alder Table Lelystad advised To70 to develop the candidate routes subject to the following constraints:

- Avoiding flying over built-up areas as much as possible;
- Avoid overflying the “old country” below 6000ft;
- Avoid overflying “Natura 2000” areas below 3000ft.

Evidently, the development of conceptual flight routes appears to have been conducted in accordance with the 3rd General Principle of airspace design.

[3] Informatiebulletin RTS en beslisoverleg Lelystad route-optics 27 en 28 maar 2017

5.5 Principle 4: Terminal Airspace should be done in a collaborative manner

The associated sub-principle recommends that Terminal Airspace design projects should be undertaken by multi-disciplinary project teams which include representatives of airspace users, operational air traffic control staff as well as instrument flight procedures design (PANS OPS) specialists. Moreover, this Principle advocates co-operation between the different ATM disciplines and between air traffic services and users during the Terminal Airspace design process.

The stage at which consultation with airspace users is undertaken should be identified by the design team e.g. airspace users tend to be involved in the design process at an early stage when the operational requirements stem from the users, and at a later stage when the operational requirements are related to air traffic management techniques and procedures. The associated sub-principles recommend that collaboration is not limited to the Air Traffic Control and operators but be extended to all interested parties including, but not limited to, the following:

- Air Traffic Control (including representatives from adjacent airspace areas);
- PANS-OPS designers;
- Airspace Users including:
  - Commercial air transport operators;
  - Military and civil;
  - General Aviation.
- Environmental bodies;
- Airport authorities;
- Regional Authorities;
- Authorities responsible for safety and environmental regulation.

From the evidence provided[4] it would appear that the conceptual development has been undertaken by a multidisciplinary team including, to varying degrees, external stakeholder engagement. It therefore appears that the development of the TMA design has involved a process of collaboration.

5.6 Principle 5: Terminal Airspace designed to be integrated into the airspace continuum

The 5th Principle advocates that Terminal Airspace should be viewed as part of the whole airspace and should therefore be aligned and integrated both vertically and laterally. This means that the routes, airspace volume and sectorisation must be compatible with adjacent routes, airspace volumes and sectorisation schemes. This of course lends further weight to the need for a collaborative approach to design discussed previously.

The conceptual design of the Lelystad TMA was developed in response to the need to connect or link the Airport (in essence the Runways) with the adjacent airways and en-route structures. Furthermore, the TMA lateral and vertical extents are formed in response to the need to integrate this new airspace structure within a complex existing airspace environment. Indeed, the real-time simulation assessment and analysis considered

[4] Informatiebulletin RTS en beslisoverleg Lelystad route-optics 27 en 28 maar 2017

integration issues. The findings of the simulation in regards integration will likely inform any subsequent refinements to detailed design (PANS OPS) of the Instrument Flight Procedures. It would appear that the 5th General Principle has been embraced in the Lelystad airport TMA design to the extent practical.

5.7 Principle 6: Terminal Airspace design following a clear design methodology

Whatever the Terminal Airspace design methodology or project management process that has been used during the development of the Lelystad airport TMA concept, the apparent components include:

- Observance of the General Principles of Airspace Design;
- Planning;
- Design Methodology;
- Validation and review.

It therefore seems clear that the development of the Lelystad airport TMA design has followed a clear design methodology.

5.8 TMA volume and containment

Turning now to the specific aspects of the Lelystad airport TMA concept, it is necessary to consider the airspace volume and the Conops B+ routes together with their vertical profiles.

The high altitude connecting routes that are to serve Lelystad airport have been developed leading to and from points at the Lelystad airport TMA boundary. Therefore, the B+ arrival routes within the Lelystad airport TMA will need to link the end of the arrival route to the Runway thresholds. Whereas the departure routes need to link the departure end of each Runway to one of the departure routes beginning at designated TMA exit points. An overview of the Conops B+ routes, designed by To70, is depicted below in Figure 3.

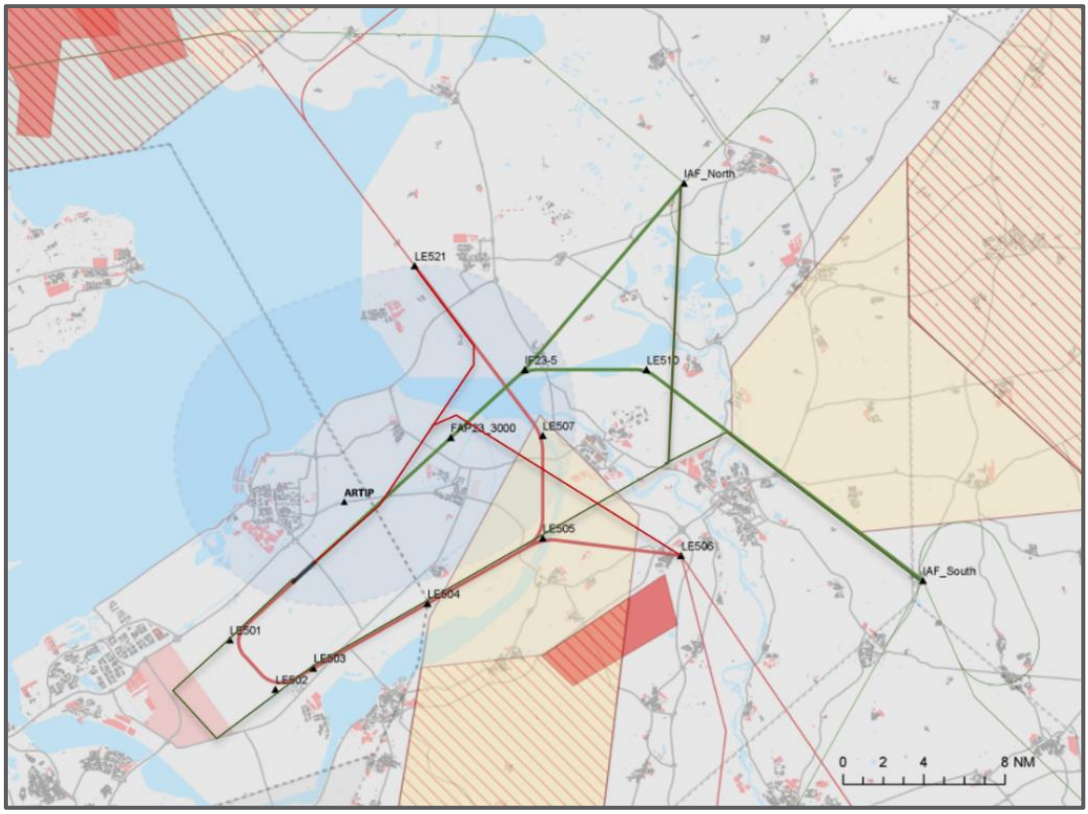

Figure 3: Conops B+ arrival routes (green) and departure routes (red) for Lelystad Airport

A more detailed plan view of the arrival and departure routes to each Runway at Lelystad airport is shown below in Figure 4 and Figure 5:

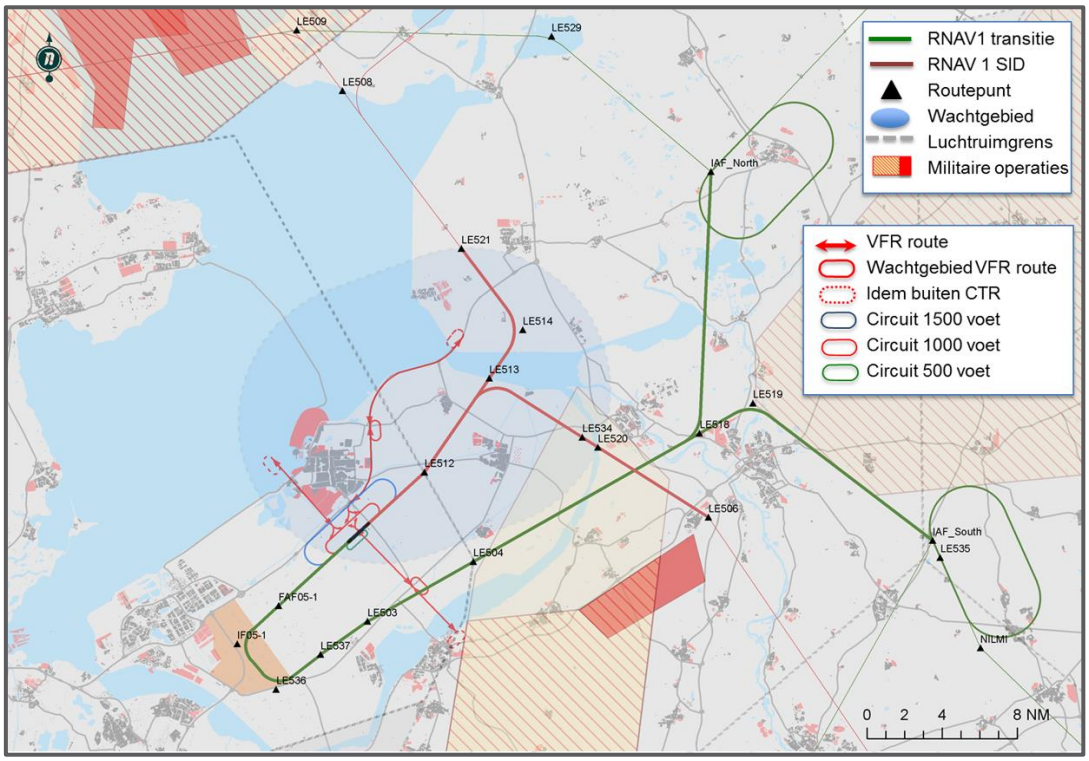

Figure 4: Arrival and departure routes Runway 05 Lelystad Airport

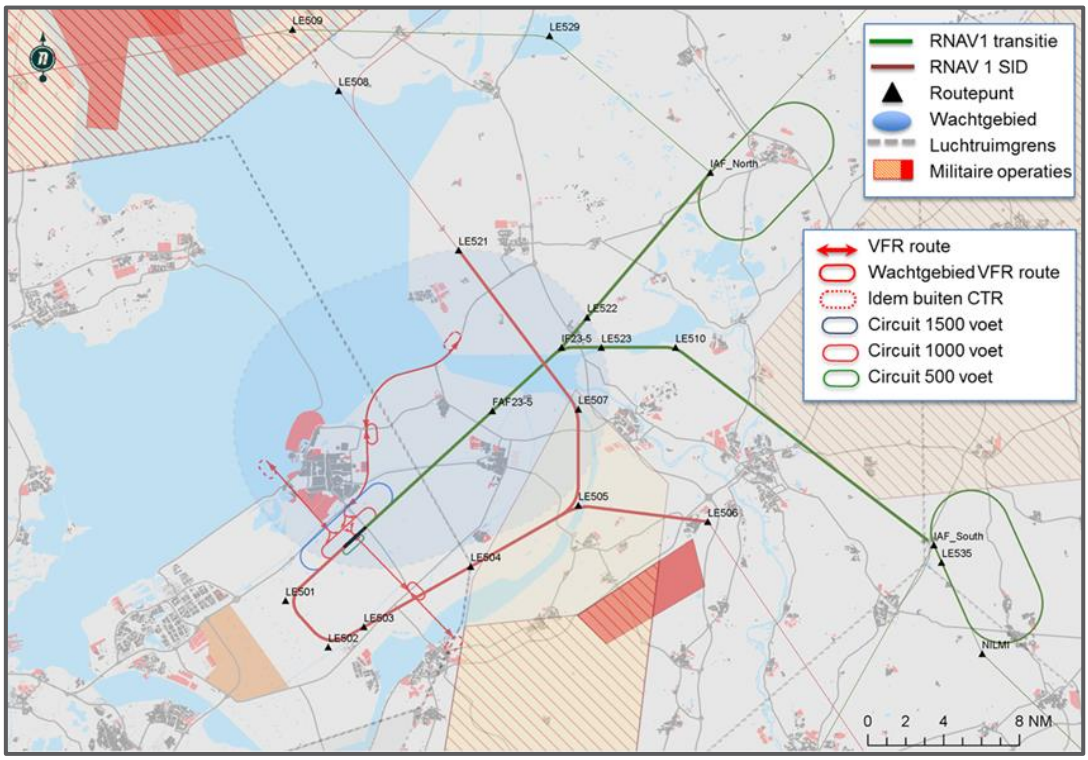

Figure 5: Arrival and departure routes Runway 23 Lelystad airport

In order to review the resultant volume of the TMA it is useful to consider the purpose of the TMA.

ICAO Annex 11 states that:

Control Areas (CTAs) and Control Zones (CTRs) for those portions of the airspace where it is determined that ATC service will be provided to IFR flights - CTAs including inter alia, Airways (AWYs) and ***Terminal Control Areas (TMAs) shall be delineated so as to encompass sufficient airspace to contain the flight paths of those IFR flights or portions thereof to which it is desired to provide the applicable parts of ATC service****, taking into account the capabilities of the navigation aids normally used in that area.*

Therefore, Terminal Airspace volume is the ‘resultant’ airspace created after the conceptual flight routes have been designed and other institutional requirements (e.g. environmental) have been considered. Thus, conceptual flight routes are designed to first

support the objectives of air traffic control and facilitate the management of air traffic whilst ensuring the protection of IFR flight paths and obstacle clearance.

The resulting TMA design for Lelystad airport is depicted below in Figure 6:

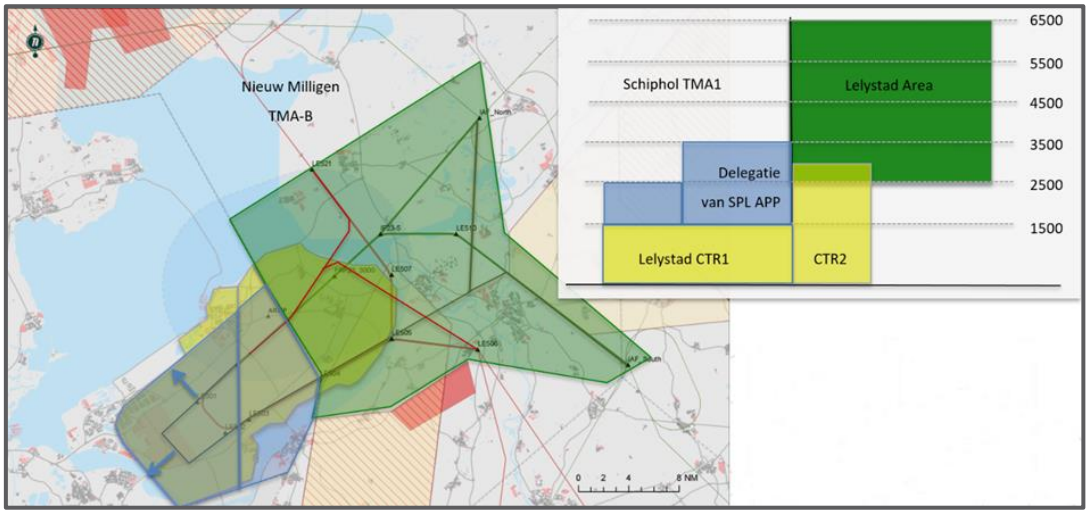

Figure 6: Lelystad Airport TMA

Evidently, the Lelystad airport TMA design appears to show adequate lateral containment of the Conops B+ arrival and departure routes.

In order to assess whether the TMA has sufficient volume to achieve vertical containment of the flight routes it is necessary to consider the vertical profiles of the proposed Conops B+ arrival and departure procedures.

The criteria for designing Instrument Flight Procedures is contained within ICAO Document 8168 (PANS OPS). When considering the vertical profile of an Instrument Flight Procedure the rate at which the aircraft is required to climb or descend, referred to as the Procedure Design Gradient (PDG), is key. Gradient is the slope of climb/descent in the segment concerned with respect to the horizontal, and is expressed in terms of percentage or degrees (e.g. 5.24% = 3 degrees = 300ft per mile). The optimum and maximum climb/descent gradients of the procedure are calculated in accordance with concerned chapters of PANS-OPS Doc. 8168, Vol-II. The optimum is the operationally preferred gradient. This should only be exceeded where alternative means of satisfying obstacle clearance requirements are impracticable. The maximum gradient shall not be exceeded.

Optimum and maximum gradients are specified/calculated depending on the type of procedure and the segment of the approach. There are 6 flight segments in the design of Instrument Flight Procedures: En-route, Arrival, Initial, Intermediate, Final and Missed Approach segments. Procedure Design Gradients are also specified for departure procedures. As we are only considering those portions of the conceptual flight procedures contained within the Lelystad airport TMA we shall review the gradients required in the Initial, Intermediate and Final segments together with the departure gradients.

Segment	Optimum Gradient	Maximum Gradient
Initial	4% (2.3 degrees)	8% (4.5 degrees)
Intermediate	Flat segment, zero gradient*	5.2% (3 degrees)
Final	5.2% (3 degrees) - 6.1% (3.5 degrees)	6.5% (3.7 degrees) Aircraft Categories A & B
		6.1% (3.5 degrees) Aircraft Categories C - E
Departure	5.8% (3.3 degrees)	7-12% Depends on aircraft type/performance

Table 2: PANS OPS approach and departure gradients

* Because the intermediate approach segment is used to prepare the aircraft speed and configuration for entry into the Final Approach segment, this segment should be flat or at least include a flat section within the segment. If, however, a descent is necessary the maximum permissible gradient will be 5.2 per cent or, if the intermediate approach speed is restricted to 165 km/h IAS (90 kt IAS), 13.2 per cent.

The vertical profiles of the arrival (green profile) and departure procedures (red profile) for Runway 05 at Lelystad airport are shown in Figure 7 below:

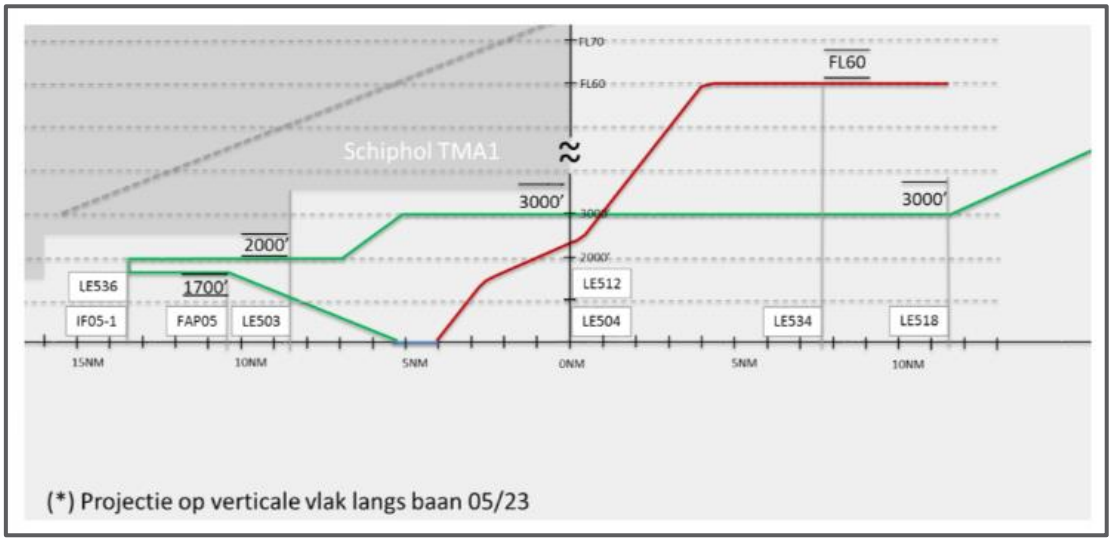

Figure 7: Vertical profiles of the arrival (green) and departure procedures (red) for Runway 05

The departure procedures are shown climbing from threshold elevation to FL060 (approx. 6000ft) over a distance of approximately 11.5 NM (to waypoint LE534); this equates to a PDG of circa 8.5%. Whereas, the arrival procedure involves a series of shallow stepped descents culminating in a final uninterrupted descent from an altitude of 1700ft to threshold over a distance of approximately 6 miles; this equates to a descent gradient of circa 5.2% (3 degrees). All conceptual design gradients therefore fall within PANS OPS criteria.

The vertical profiles of the arrival (green profile) and departure procedures (red profile) for Runway 23 at Lelystad airport are shown in Figure 8 below:

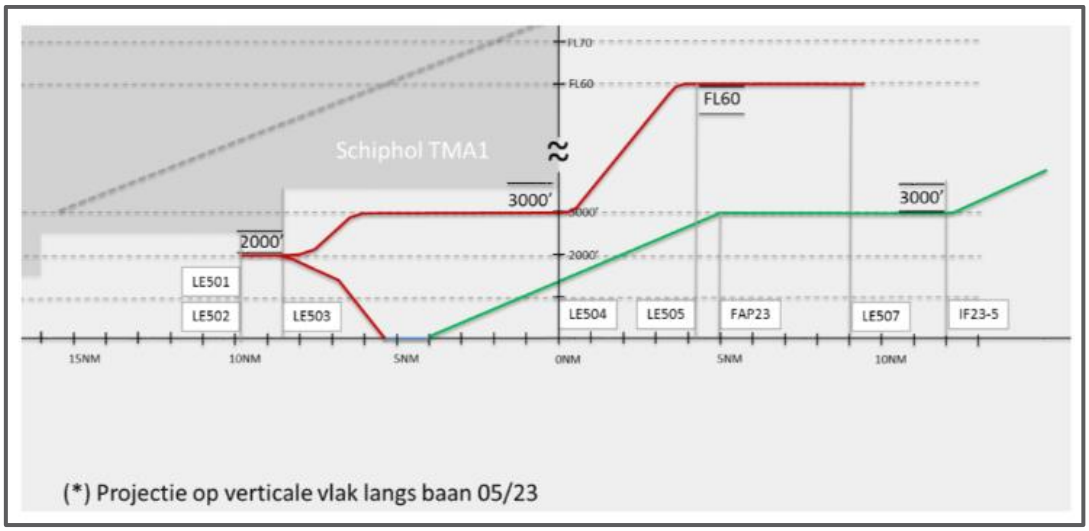

Figure 8: Vertical profiles of the arrival (green) and departure procedures (red) for Runway 23

The departure procedures are shown with a series of interrupted climbing segments in order to keep departing aircraft within the stepped vertical limits of the TMA. The steepest portion involves a climb from altitude 3000ft to 6000ft over a distance of approximately 5 NM; this equates to a PDG of circa 9.9%. Whereas, the arrival procedure involves a series of shallow stepped descents culminating in a final uninterrupted descent from an altitude of 3000ft to threshold over a distance of approximately 8 NM; this equates to a descent gradient of circa 5.2% (3 degrees). All conceptual design gradients fall within PANS OPS criteria.

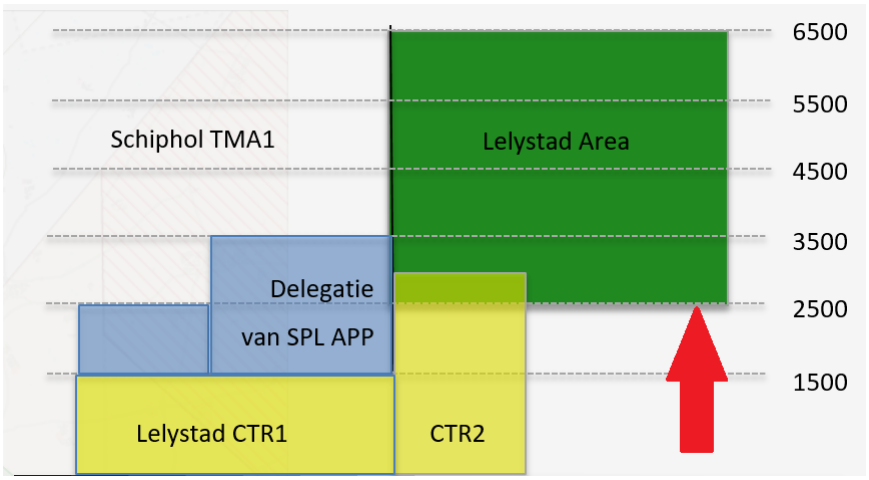

Figure 9: Vertical cross section of Lelystad TMA

5.9 Our observations

In general, we are content that the approach taken to the Lelystad airport TMA design broadly accords with the EUROCONTROL General Principles of Terminal Airspace design.

We have assessed that the resulting volume of TMA airspace is sufficient to contain the conceptual flight routes, which in turn appear feasible in terms of anticipated compliance with (PANS OPS) procedure design gradients.

We note that whilst the Lelystad TMA achieves vertical containment of the Conops B+ routes, the base level of the Lelystad airport TMA in the vicinity of the Initial Approach Fixes at 2,500ft (as shown below in Figure 9) seems unnecessarily low, when the stated requirement is for inbounds to maintain a minimum of FL060 and to descend to 3,000ft 'as late as possible'.

Finally, we note that there will be some changes to airspace classification to afford protection to commercial traffic exiting the Lelystad airport TMA and in the vicinity of the inbound holds have been proposed in the surrounding NM TMAs; namely changing from Class E to Class D between FL055 and FL065 (FL095 at weekends). It is our opinion that this is a necessary consequence of the Lelystad airport TMA design which itself is constrained vertically by being situated below busy inbound traffic streams to Schiphol airport.

6 Assessment of the KNVvL study; Expansion of Lelystad Airport Version 1.5

6.1 Scope

The Royal Netherlands Association for General Aviation (KNVvL) has produced a document for the State Secretary suggesting an alternative airspace design to connect Lelystad airport to the route network (KNVvL study paper version 1.5 dated 24 July 2017).

The State Secretary has asked LVNL to comment on the KNVvL document and has asked us to assess the document. The MoT is asking Helios to specifically look at options that can be of use within the timeframe to start operation at Lelystad airport (i.e. April 2019).

6.2 Approach

We have reviewed the KNVvL study paper version 1.5 dated 24 July 2017 and its suggestions for optimizing airspace design.

We have conducted an overall review of the paper and have then sought to respond to specific points. We have also sought to identify potential solutions proposed by KNVvL (and, where appropriate through consultations with other stakeholders), that should be considered for implementation.

6.3 Overview of KNVvL study paper

The study paper provides a useful platform from which to support discussions aimed at findings potential solutions to secure airspace for airports, or to limit the restrictions imposed by Lelystad operations. The paper is constructive and offers potential solutions to identified challenges.

The report's overall assertion is that the Lelystad CTR/TMA is too large, and that the Amsterdam CTAs (Control Area) contain a volume of controlled airspace that is 'hardy used' and which could allow Lelystad and Schiphol traffic to operate at higher levels, thereby allowing GA greater access to the airspace beneath the CTAs.

Key statements in the lead paragraph assert that cross-country flying in the East of the Netherlands (especially for non-motorized planes) will be made practically impossible, and that the proposed route overhead Teuge Airport will lead to a closure of the National Parachuting Centre.

In addition, KNVvL expresses frustration at a perceived inadequate level of consultation over the past years whilst Lelystad Airport designs have been progressing. However, it is noted that closer consultation and discussion is currently taking place.

6.4 Specific statements and responses

It is only possible to respond to specific statements that are sufficiently detailed and are directly related to the development of the propose connecting routes and associated airspace changes in respect of Lelystad airport.

Statements in italics are reproduced verbatim from the study paper. The numbered "Conflict Areas" are as referenced in the study paper itself.

6.4.1 **Page 7:** *"The STAR inbound EHAM via ARTIP prescribes to cross ARTIP between FL70 and FL100. (Note: with strong westerly wind conditions ARTIP will be crossed around FL90 on an optimal CDA approach straight-in for RWY 27, including a deceleration segment)."*

Flight Levels vary considerably in actual height above the ground, with changing atmospheric pressure. Waypoint ARTIP is approximately 30 NMs from touchdown for Runway 27 so around 9,000ft would be acceptable for a CDA. However, FL090 could be anywhere between 8,000ft and 10,000ft depending on the prevailing atmospheric pressure. Coupled with our observation that achieving levels low and slow enough for vectoring consecutive inbounds via waypoint ARTIP can be a challenge when presented with converging streams of traffic to sequence, we would exercise caution in suggesting that substantially higher levels could be operationally acceptable. However, we would suggest closer examination is given to a minimum stack level of FL080.

6.4.2 **Page 13: Concern around Conflict Area 1**

Whilst we are unable to comment on the issues expressed regarding previous consultation and work processes, it is difficult to understand the requirements of individual airfields/activities from this study paper. The impact on GA is expressed in terms of e.g. "stringent" or "tight" restrictions. We would recommend that objective requirements are provided in order to understand the actual impact of the proposed changes. As mentioned in Section 3, it is possible that more recent proposals of a raised base level may have mitigated some of the constraints initially caused by the Lelystad airport TMA design.

The size of the TMA is also expressed as a concern as the study believes it will reduce GA flying activities.

We are not aware of is any consultation regarding procedures that has taken place (or is planned to) regarding airspace access arrangements. Class D airspace does not preclude VFR flight; indeed, it is expected that VFR operations will co-exist with commercial flights at Lelystad for the foreseeable future, although local training traffic in the airport vicinity is likely to continue to restrict general crossing traffic as no doubt it does today. Crossing at higher altitude, for instance through the Lelystad airport TMA and outside the boundaries of the Schiphol airport TMA, would seem to be acceptable; traffic permitting. At first, ATC is likely to be conservative as familiarity with the airspace, routes, traffic performance and peculiarities of the operation needs to be gained. The anticipation however would be that in time the airspace classification and ATC service provided would be of minimum restriction to GA whilst affording the necessary protection to commercial airline services.

"A large part of the airspace towards the south of the TMA area will be restricted unnecessary by the fact that outbound traffic is restricted in their climb by a maximum level of FL060."

There is a possible difference of understanding here. Our belief is that the published SID level of FL060 would not prevent ATC from climbing an aircraft above that level (subject other traffic or course) as is common practice.

6.4.3 **Page 14:** *"Approaching air traffic seldom descents below FL150 before the RNAV points OSKUR or NOVEN."*

These fixes are both 17 NMs before waypoint ARTIP and well to the West of IAF North and South. We would request LVNL respond to this assertion as it does not accord with the data we have seen. However, both fixes are approximately the same distance from Lelystad airport as fix LE510, where inbounds following the RNAV transition for Runway

23 would have to be at approximately 6,000ft, therefore we are not sure of the relevance of this statement.

The study suggests that the projected Lelystad airport CTR is *"laterally unnecessary large, especially when the planed SID and STAR routes are implemented, this results in less space for safe VFR routes".*

The reference to 'safe VFR routes' has been confirmed as simply meaning routes for VFR traffic clear of commercial traffic.

Page 15: A list of suggestions is made which generally entail all traffic into Schiphol airport (via waypoint ARTIP) flying at higher levels than present, thus allowing Lelystad arrivals to also fly higher levels (effectively CDAs) beneath them; depicted in Figure 8 in the study paper. Schiphol airport is further West than Lelystad airport so there is a logic to this idea for traffic inbound from the East. Suggested descent levels for Lelystad airport arrivals have also been uploaded to a web-map which we have been shown. As an example; the route via waypoint REKKEN is shown as crossing waypoint REKKEN at FL180 and IAF South at FL110 (although the text on page 19 of the study suggests IAF South would actually be crossed at approx. FL090 on a CDA). Routes via IAF North follow similar CDA-type profiles. Whilst theoretically sound when considering individual aircraft, a more complete assessment of this suggestion would have to include representative Schiphol airport traffic; including arrivals through Sector 2 which also route via waypoint REKKEN, and departures through Sector 1.

Whilst the arrival rate into Lelystad airport (in the early years) would in theory lend itself to individual preferred trajectories for those Lelystad airport inbounds to be flown, periods of high inbound demand peaks through waypoint ARTIP currently would not sustain such profiles. The requirements of slowing and sequencing this traffic do not favour CDAs without some additional form of long-range metering, and restricting Schiphol airport to higher-level inbound profiles may not be operationally feasible in the short-term. To draw a parallel, the current operation of London City airport necessitates early descent and long/low transitions to keep traffic below the busy airspace serving Heathrow airport and other London airports. The implementation of London City airport maintained the capacity and network quality of the London airports, but it did entail some necessary changes to levels and procedures in the lower levels (e.g. vectoring for Heathrow arrivals).

We recommend the suggestions form input to future airspace design work as trajectories supported by metering and merging tools are expected to form a part of the future operation.

6.4.4 Page 19: Concern around Conflict Area 2

A number of observations and suggestions are made regarding the design of the connecting routes in the Teuge airport area. Some of the comments relate to Lelystad departures having to maintain low level for long (inefficient) periods, and that they are not allowed to use CTA Amsterdam. Our understanding of the procedure is that AOCS NM would control the traffic (initially) below CTA Amsterdam, but with coordination it will then climb into the CTA under the control of ACC to be merged with other commercial traffic and achieve its required exit level. The same would be the case in the opposite sense for inbounds, so this may be a misunderstanding caused by lack of detailed information. A comment is also made regarding conflicting routes, but they are not designed to be procedurally separated so this should not be a concern.

The main issue, and the suggestions contained on page 21, concerns routing through the Teuge airport area. This is covered in Section 3 of our report.

Assigning Minimum Crossing Altitudes (MCA's) to various Schiphol airport outbound fixes may have merit, but the hope is that this will not be necessary in the short-term if an acceptable route or procedure can be developed with Teuge airport to permit Lelystad airport traffic to depart and be merged with outbound flows whilst not being unduly height restricted. It should be noted as a possibility however, to help achieve earlier climb from Lelystad airport if this proves otherwise to be too constrained or high-workload.

6.4.5 Page 23: Concern around Conflict Area 3

All points are noted, but the evidence is that this region has been fully assessed and developed through the design and simulation testing stages. AOCS NM (within Amsterdam ACC following co-location) will control traffic through this area until handover to ACC, with agreed procedures and allocation of levels. INB-S3 and OUT-S3 are the result of this development work. We defer to LVNL/CLSK to comment on the detailed airspace and route design suggestions which follow (page 25). Similarly, we have no comments to make regarding the suggestions for the Northern area (Conflict Area 4); again, LVNL and/or CLSK may wish to respond.

7 Potential options for further consideration

Using input from our review and proposals from stakeholders, we have proposed four potential options to address some of the identified challenges.

- Option 1: Positive control of Lelystad para-drop aircraft.
- Option 2: Combination of raising minimum stack level at ARTIP to FL080, allowing EHLE inbounds from IAF 'South' at FL070 and raising the South-Eastern TMA base level to FL055.
- Option 3: Raising eastern portion of Lelystad TMA base level to FL045.
- Option 4: Schedule/temporal deconfliction between EHLE departures and Sector 2 peaks to enable OUTB-04.

We have undertaken a qualitative assessment of each option, including whether they could be implemented in the short term (by April 2019) or in the longer term as part of a more comprehensive airspace design.

Our assessment indicates that whilst all of the options could deliver potential benefits, none of the options are entirely positive. All options will require a more detailed operational assessment, including assessing the impact on stakeholders. The decision to implement one or more of the options should consider the impact on all stakeholders and balanced with the requirements of the project as a whole.

Please note, this assessment is qualitative and is based on expert judgement expressed using the following indicators:

Indicator	Description
++	Strong positive effect
+	Positive effect
0	No effect
-	Negative effect
- -	Strong negative effect
TBD	To be Determined – insufficient data available
√	Yes
X	No or Unlikely

	Option 1 Positive control of para drop aircraft	Option 2 ARTIP minimum stack FL080, EHLE inbounds IAF South FL070, South-eastern EHLE TMA base raised to FL055.	Option 3 Raising Eastern portion of Lelystad TMA base level to FL045	Option 4 Schedule deconfliction between EHLE Departures and Sector 2 peaks, to enable OUTB-04
Operational feasibility	TBD	TBD	√	TBD
Compatible with the constraints as set by the Alders-process	√	TBD	√	√
Compatible with Conops B+ profiles (lateral and vertical)	√	√	√	√
Environmental effect, especially introduction of new areas that are overflown	0	0	0	0
Impact on controller workload compared to the current design	-	TBD	0	-
Impact on complexity in the current ATM Concept compared to current design	-	TBD	0	-
Impact on Schiphol operations: TMA capacity, ACC sector capacity, sustainability	TBD	TBD	0	0
Impact on military operations	-	0	0	-
Impact on GA-stakeholders: Teuge para dropping Gliding, including Lemelerveld	 ++ 0	 0 +	 0 ++	 ++ 0

	Option 1 Positive control of para drop aircraft	Option 2 ARTIP minimum stack FL080, EHLE inbounds IAF South FL070, South-eastern EHLE TMA base raised to FL055.	Option 3 Raising Eastern portion of Lelystad TMA base level to FL045	Option 4 Schedule deconfliction between EHLE Departures and Sector 2 peaks, to enable OUTB-04
Feasibility to incorporate in current design while maintaining current planning with delivery April 2019	TBD	TBD	√	√
Potential to incorporate in expected (longer-term) future national airspace redesign effort	X	√	√	X
Notes:	Increase in workload for military ATCOs working para drop aircraft, this would be in addition to increased workload resulting from having to tactically separate military traffic in TRA 12 and TRA Wamel from Lelystad traffic. Any effect on workload of civil ATCOs TBD. We expect that this could only accommodate limited Lelystad movements in the short-term. Portion of route going through segregated airspace would have to be established as CDR1 and annotated as permanently plannable.	A technical assessment of this option would need to consider the impact on the TMA operations as a whole. One of the key issues to address would be the descent profile for inbounds after leaving ARTIP; in particular, to Runway 27.	Raising base level from 2500ft would allow increased access for civil/military VFR/transit traffic below Controlled Airspace without the requirement for ATC clearance (i.e. in Class E airspace).	Operator acceptability and sustainability of schedule deconfliction at EHLE is questionable. Small increase in workload on ACC controller is expected, but this will not impact capacity. Short-term solution only; would not form part of future airspace re-design

Table 3: High-level assessment of potential options for implementation

A Annex

A.1 List of acronyms

Below is a list of the acronyms used throughout this report.

Acronym	Meaning
ACC	Area Control Centre
ANSP	Air Navigation Service Provider
AOC	Air Operator Certificate
AOCS	Air Operations Control Station
APP	Approach Control
ATM	Air Traffic Management
ATS	Air Traffic Service
AUP	Airspace Use Plan
CDA	Continuous Descent Approach
CDR	Conditional Route
CLSK	Commando Luchtstrijdkrachten (Royal Netherland Air Force)
CNS	Communication and Navigation System
Conops	Concept of Operations
CRAM	Conditional Route Availability Message
CTA	Control Area
CTR	Controlled Traffic Region
FL XXX	Flight Level XXX
FUA	Flexible Use of Airspace
GA	General Aviation
IAF	Initial Approach Fix
ICAO	International Civil Aviation Organisation
IFPS	Initial Flight Plan Processing System

IFR	Instrument Flight Rules
KNVvL	Koninklijke Nederlandse Vereniging voor Luchtvaart (Royal Netherlands Association for General Aviation)
LVNL	Luchtverkeersleiding Nederland (Netherland Air Traffic Control)
MCA	Minimum Crossing Altitude
MoT	Ministry of Transport
MUAC	Maastricht Upper Area Control
NM	Nieuw-Milligen (Air Operations Control Station)
PDG	Procedure Design Gradient
RNAV	Area Navigation
RTS	Real-Time Simulation
SID	Standard Instrument Departure
SSR	Secondary Surveillance Radar
STAR	Standard Terminal Arrival Route
TMA	Terminal Manoeuvring Area
TRA	Temporary Reserved Area
VFR	Visual Flight Rules

Table 4: List of acronyms