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E.N.A.C
ENTE NAZIONALE per L'AVIAZIONE CIVILE

Committente Principale

AEROPORTO INTERNAZIONALE DI FIRENZE AMERIGO VESPUCCI

Opera

PROJECT REVIEW – PIANO DI SVILUPPO AEROPORTUALE AL 2035

Titolo Documento

NUOVO TERMINAL PASSEGGERI
Impatto del Nuovo Terminal sull'azione del vento in relazione alla Pista Esistente e Nuova

Livello di Progetto

SCHEDE DI APPROFONDIMENTO PROGETTUALE

A LIVELLO MINIMO DI PROGETTO DI FATTIBILITÀ TECNICA ED ECONOMICA

LIV	REV	DATA EMISSIONE	SCALA	CODICE FILE
PSA	00	MARZO 2024	N/A	FLR-MPL-PSA-TRM2-007-WS-RT_Wind Study Runway
				TITOLO RIDOTTO Wind Study Runway

02	03/2024	EMISSIONE PER PROCEDURA VIA-VAS	J. Wacker	D. PERRI	L. TENERANI
REV	DATA	DESCRIZIONE	REDATTO	VERIFICATO	APPROVATO

COMMITTENTE PRINCIPALE	GRUPPO DI PROGETTAZIONE	SUPPORTI SPECIALISTICI
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Intro

Il presente documento costituisce lo studio dell’Impatto del Nuovo Terminal sull'azione del vento in relazione alla Pista Esistente e Nuova. Questo è da considerarsi parte integrante della Project Review del Piano di Sviluppo Aeroportuale (o Masterplan) al 2035 dell’aeroporto di Firenze, qui sviluppata e dettagliata ad un livello tecnico ritenuto congruo con le finalità della presente fase procedurale, comunque non inferiore a quello del progetto di fattibilità tecnica ed economica di cui all’art. 41 del D. Lgs. n. 36/2023.

Il citato approfondimento tecnico viene previsto ad integrazione della Sezione Generale della Project Review del Piano di Sviluppo Aeroportuale al 2035, predisposta in aderenza alle normative e/o regolamenti specifici del settore aeronautico, rispetto alla quale si pone l’obiettivo di elaborare ulteriori elementi tecnici di studio, dettaglio, analisi e progettazione, ritenuti necessari ai fini del compiuto espletamento dei procedimenti amministrativi (di compatibilità ambientale e di autorizzazione) ai quali risulta per legge assoggettato lo strumento del Piano di Sviluppo Aeroportuale, così integrato in modo da rafforzarne la valenza e la funzione progettuale, strettamente interconnessa con quella pianificatoria e programmatica di investimento.

Le informazioni di seguito riportate vanno, pertanto, analizzate in stretta correlazione rispetto ai più ampi ed estesi aspetti tecnico-economici trattati all’interno dei documenti afferenti alla Sezione Generale del Masterplan, con i quali esse si relazionano secondo un processo capillare di progressivo approfondimento e dettaglio, ritenuto utile per una più completa, consapevole e piena visione dell’insieme delle previsioni di trasformazione dello scalo aeroportuale e delle aree circostanti, e per una più esauriente analisi e comprensione della Project Review del Piano di Sviluppo Aeroportuale.

La citata Project Review costituisce la nuova formulazione tecnica delle previsioni progettuali e di investimento che ENAC prevede di attuare, nel medio-lungo periodo (orizzonte 2035, coerente con quello del Piano Nazionale degli Aeroporti in fase di aggiornamento), relativamente all’infrastruttura aeroportuale di Firenze, redatta dal Gestore aeroportuale di intesa con l’Ente regolatore in attuazione degli obblighi di miglioramento, ottimizzazione e sviluppo dell’aeroporto insiti nel contratto di concessione che lega lo stesso Gestore alle Istituzioni dello Stato (Ministero delle Infrastrutture e ENAC) per la gestione totale dell’infrastruttura aeroportuale (bene dello Stato). Ne consegue che l’insieme documentale di cui la presente relazione costituisce parte integrante deve essere visto e analizzato nella propria autonomia e indipendenza sostanziale, per quanto inevitabilmente consequenziale rispetto al precedente Masterplan 2014-2029 col quale risultano ancora sussistenti più elementi di dialogo che, tuttavia, ci si pone l’obiettivo di non assurgere a valenza prodromica e a funzionalità necessaria per una completa illustrazione, definizione e comprensione del nuovo Piano di Sviluppo Aeroportuale 2035.

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Si auspica, infine, di aver esaurientemente e correttamente tradotto e trasferito, all'interno della documentazione di cui al nuovo Masterplan 2035, quel prezioso bagaglio di esperienza e quell'insieme di utili risultanze derivanti dal dialogo costruttivo e dialettico che, nell'ultimo decennio, ha visto in più momenti la partecipazione di ENAC, del Gestore aeroportuale, degli Enti/Amministrazioni interessati, delle Istituzioni nazionali e regionali, dei vari stakeholders e della cittadinanza attiva intorno ai temi relativi al trasporto aereo, alla multimodalità della mobilità, al ruolo della rete aeroportuale territoriale toscana e al futuro dello scalo aeroportuale di Firenze, che ENAC vede sempre più strategico, integrato e funzionale alla rete nazionale ed europea dei trasporti.

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Florence International Airport

(Florence, Italy)

Wind Engineering Services (Desk study and CFD simulation):

Impact of airport building (new terminal) on wind characteristics above runway (existing and new one)

Client: Toscana Aeroporti S.p.A.

Project Engineer: Dr.-Ing. A. Richter

Birkenfeld, 14.11.2023

Prof. Dipl.-Ing. J. Wacker
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1 Introduction

At the Florence International Airport in Florence, Italy, a new terminal building (see Fig. 1.1) as well as a new runway (s. Fig. 1.2) are planned. In this context wind engineering services are requested. The location of the planned project is shown in Fig. 1.3.

Wacker Ingenieure Consulting Wind Engineers, Germany, were commissioned to investigate the following wind engineering aspects by means of numerical flow simulations (CFD) and desk study:

- Wind comfort at pedestrian level (drop-off/pick-up area breezeway, breezeway between baggage terminal building and parking area)
- Impact of airport building on wind characteristics above runway (existing and new one)

In the present report the **results of the second aspect (impact on runways)** are documented.

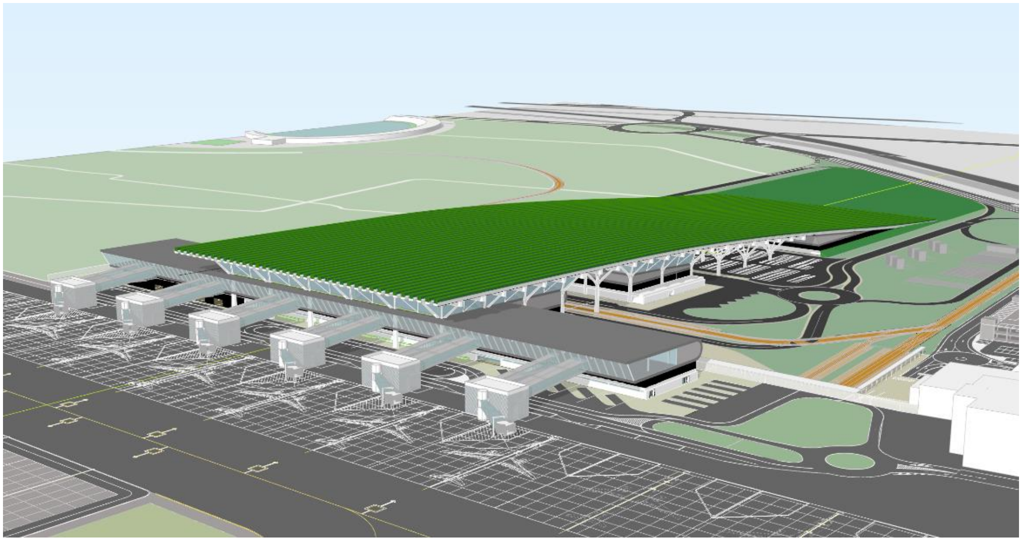


Fig. 1.1: Visualization of Florence International Airport in Florence, Italy (from RVA, 2023)

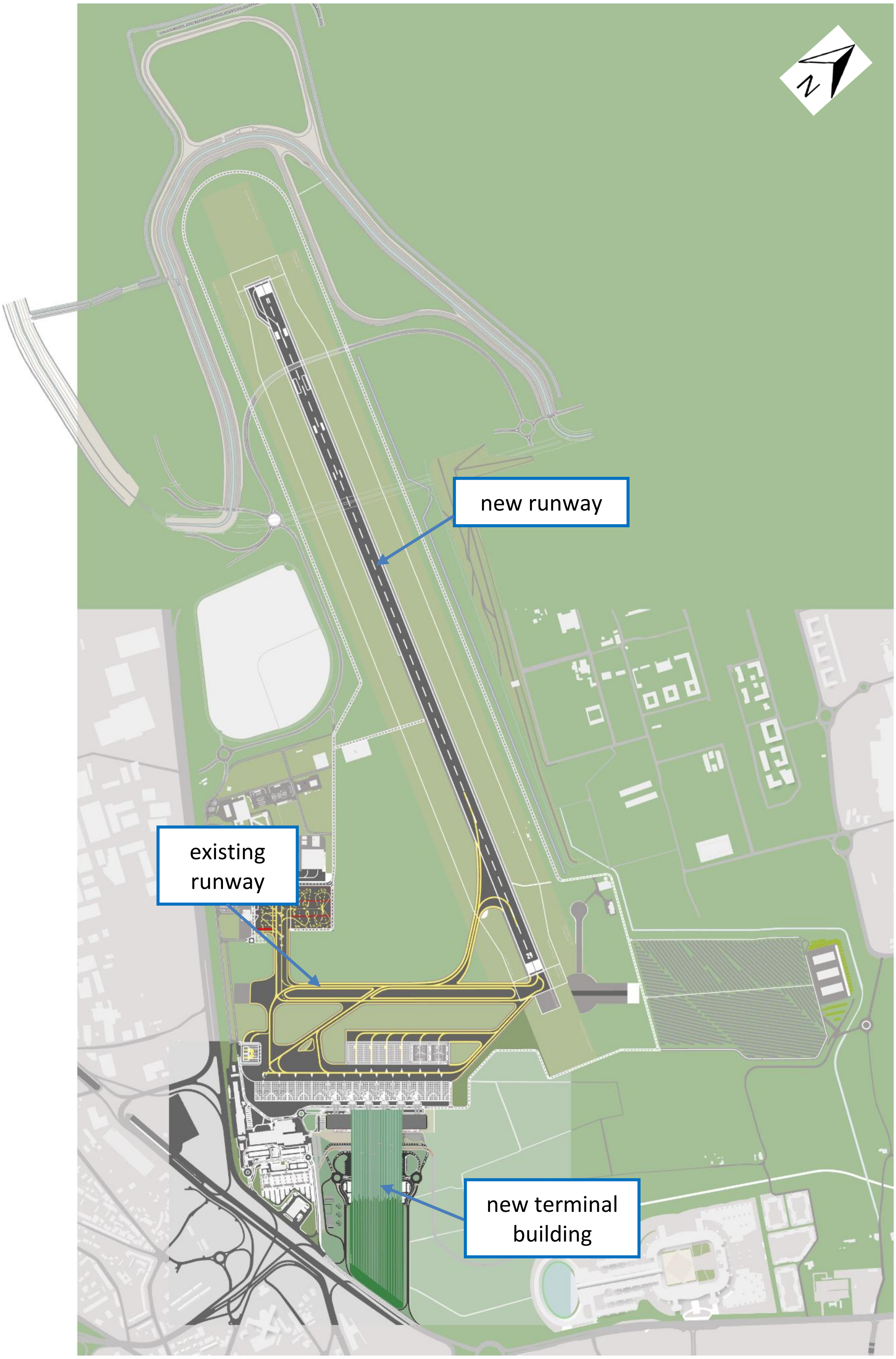


Fig. 1.2: Site plan with planned terminal building and planned new runway (RVA, 2023)

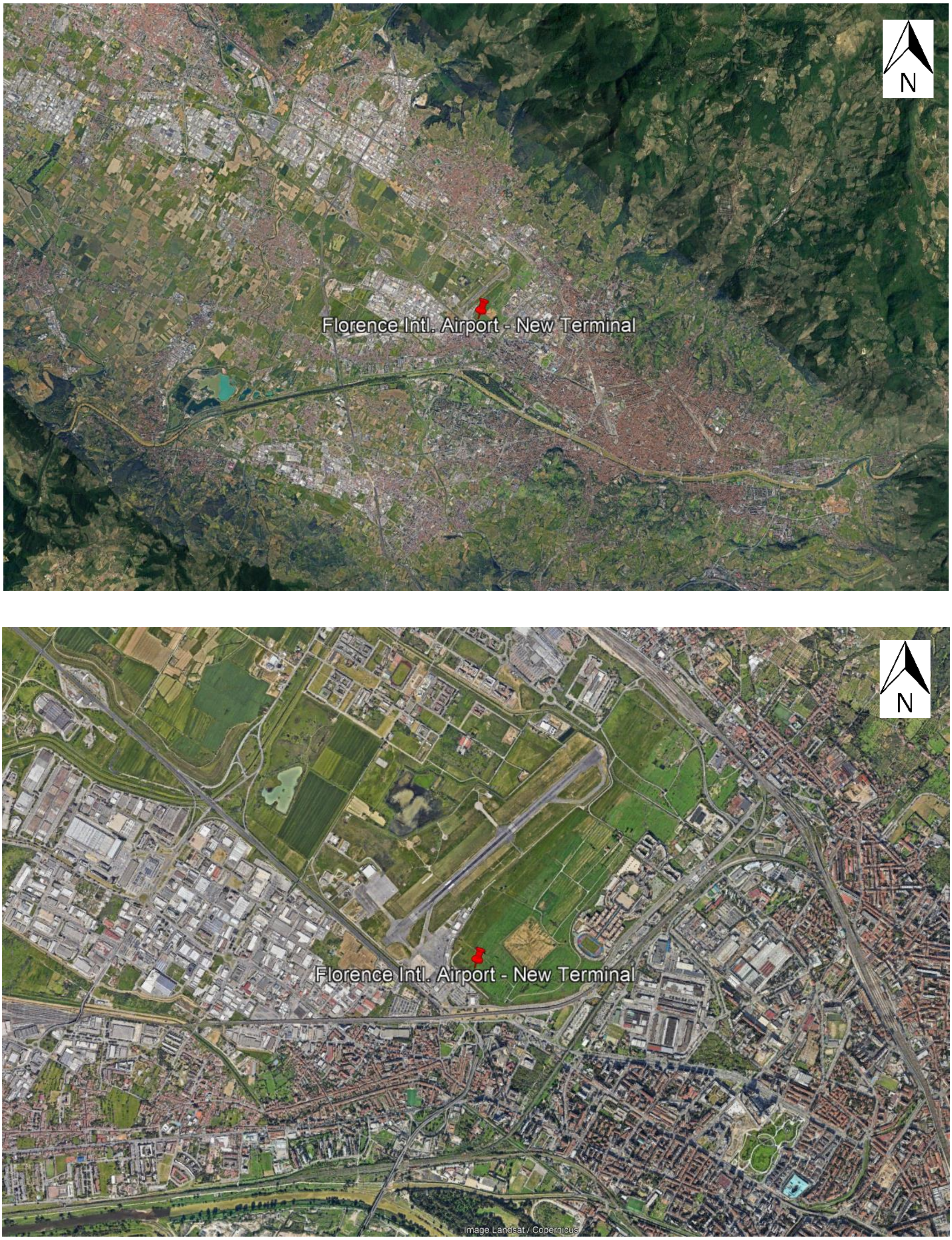


Fig. 1.3: Location of the planned project in Florence, Italy (Google Earth, 2023)

2 Procedure, Methodology

2.1 Boundary conditions

The new terminal building has a height of about 28 m, a length of ca. 420 m and a width of about 150 m (main building) to 300 m (at the gateways).

The new terminal is planned about 350 m south-east of the existing runway whereas the planned runway is located north of the existing one (s. Fig. 1.2).

2.2 Numerical flow simulations

Numerical flow simulations were performed to determine the wind speeds using the open source program OpenFOAM (Open Source Field Operation an Manipulation).

For the numerical solution of the conservation equations, a suitable computational grid must be generated. In the simulations performed here, only structured computational grids were used. During the grid generation, the relevant areas were resolved more finely, this means a local refinement near the wall and the floor. A computational grid with approx. 12 million grid cells was generated. This was based on the 3D-model provided by the architects (RVA, 2023). The surrounding development was taken into account in a radius of approx. 500 m. The 3D model used for the simulation is shown in Fig. 2.1.

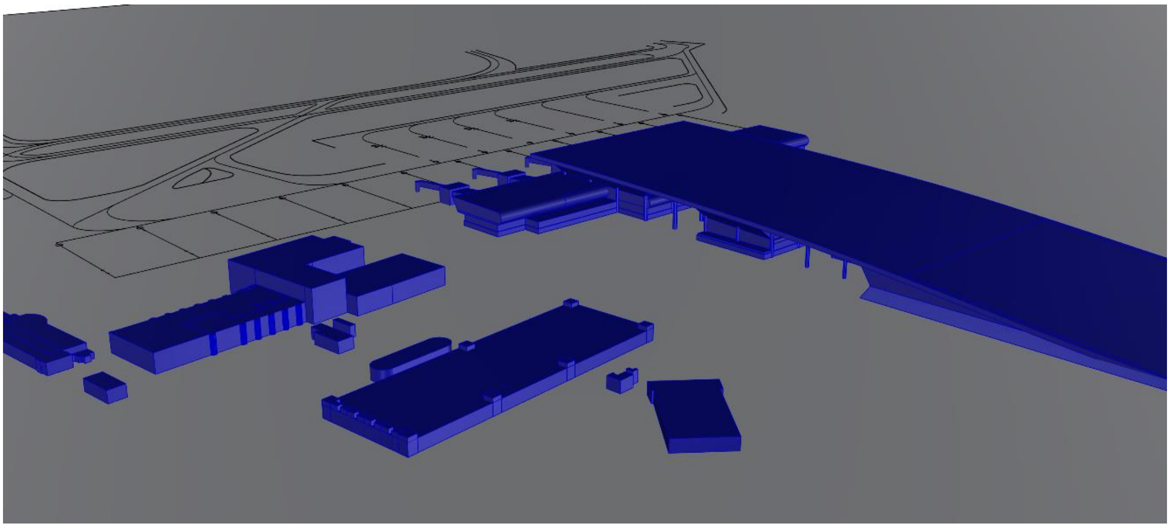
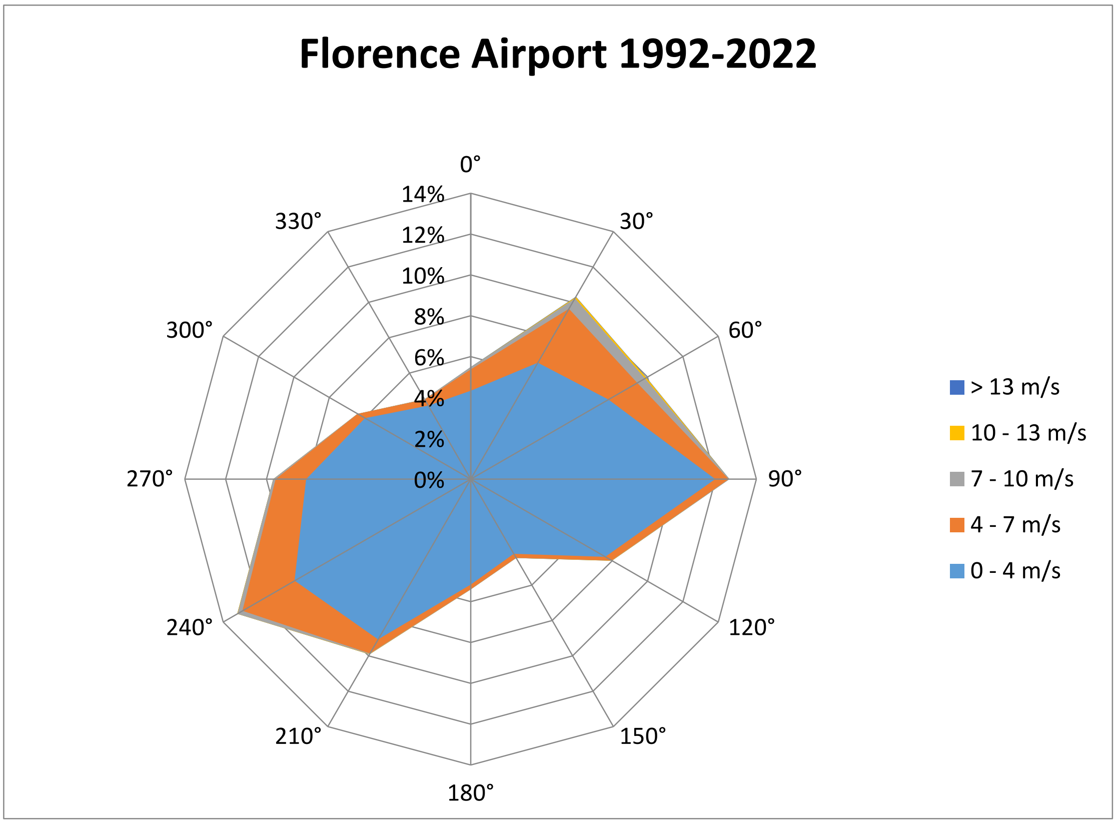


Fig. 2.1: 3D model of the new terminal and existing buildings based on the provided information (RVA, 2023) (planned status)

2.3 Wind climate at site

Long-term wind climate data from the nearest weather station at Florence Intl. Airport were used to evaluate wind comfort and wind safety. Specific frequency distributions of wind speeds were generated from the climate data (Fig. 2.2). These are average frequency distributions. It should therefore be noted that deviations from the average may occur in individual years.

For the application of the statistics, the influence of the different ground roughness of measuring station and project site according to EN 1991-1-4 (2010) was taken into account.



wind direction	Exceedance frequency of certain wind speeds											
	0 m/s	1 m/s	2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	13 m/s
0°	5.5%	3.6%	2.7%	1.8%	1.2%	0.4%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%
30°	10.3%	7.3%	5.8%	4.7%	3.7%	1.9%	1.4%	0.7%	0.3%	0.2%	0.1%	0.0%
60°	10.0%	6.6%	4.4%	2.8%	2.2%	1.2%	0.9%	0.5%	0.3%	0.2%	0.1%	0.0%
90°	12.7%	8.4%	5.3%	1.7%	0.7%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
120°	8.0%	5.3%	3.3%	1.1%	0.4%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
150°	4.5%	2.8%	1.6%	0.5%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
180°	5.4%	3.4%	1.9%	0.6%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
210°	9.9%	6.6%	4.4%	1.9%	0.8%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
240°	13.2%	9.4%	7.1%	4.8%	3.2%	1.2%	0.7%	0.3%	0.1%	0.0%	0.0%	0.0%
270°	9.7%	6.6%	4.7%	2.8%	1.6%	0.5%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%
300°	6.4%	4.0%	2.5%	1.1%	0.4%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
330°	4.5%	2.7%	1.7%	0.8%	0.4%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
total:	100.00%	66.79%	45.38%	24.63%	15.08%	5.97%	4.13%	1.91%	0.89%	0.44%	0.21%	0.03%

Fig. 2.2: Sum frequency in [%] for different mean wind speeds and wind directions of the weather station at the Florence International Airport

2.4 Investigated configurations

In order to investigate the impact of the new terminal on the flow situation compared to the existing situation, the following two configuration were considered:

1) Current status: existing buildings without new terminal building

2) Planned status: existing buildings including the new terminal building

For each configuration two wind directions were simulated: wind direction 132° (south-east) where the new terminal is located upwind of the existing runway and wind direction 240° (south-west) which is one main wind direction at site (s. Fig. 2.3). Thus, in total 4 simulations were performed.

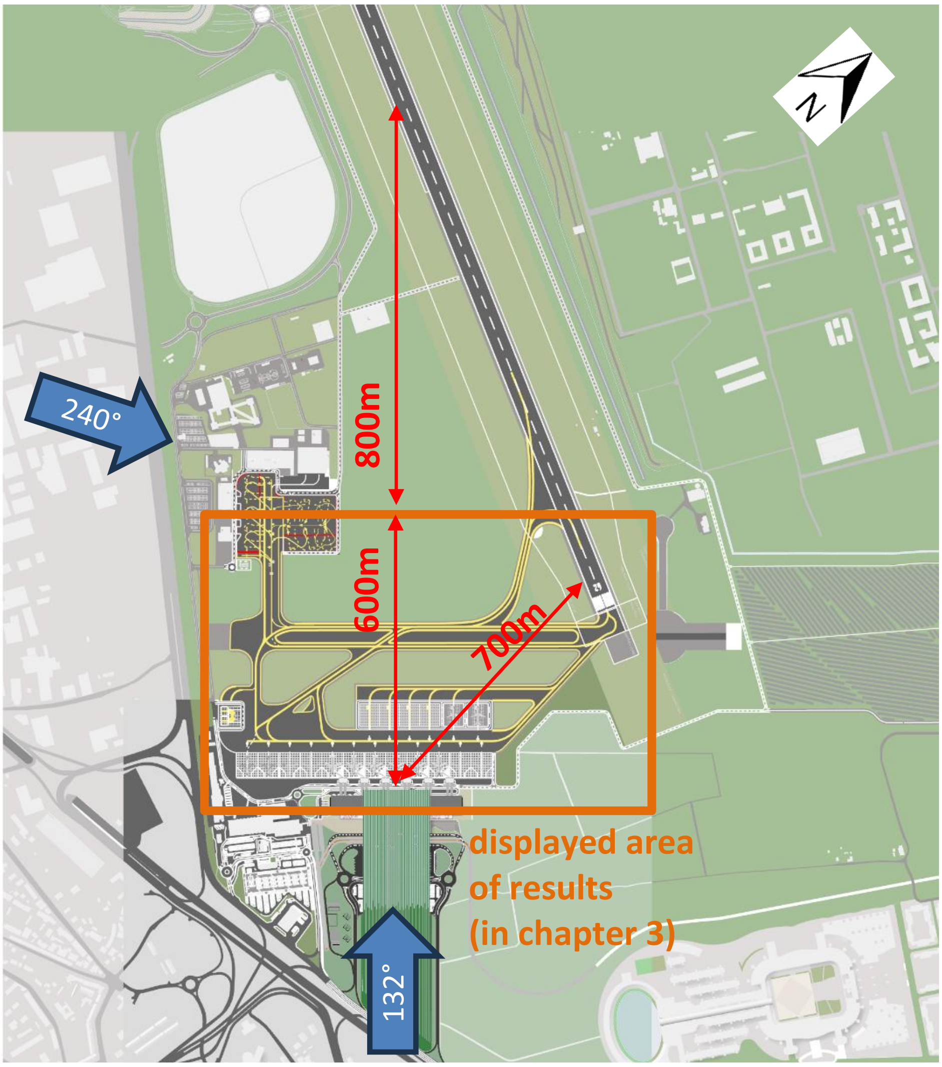


Fig. 2.3: Investigated wind directions, distances and area where the results in chapter 3 are displayed

3 Simulation results

Impact on the existing runway

In order to compare the actual and planned situation at the runway, the mean velocities were evaluated at different heights above the runway (10 m, 20 m, 30 m). This is shown in plan views in Fig. 3.1 to Fig. 3.3 for wind direction south-east (132°) and in Fig. 3.5 to Fig. 3.7 for wind direction south-west (240°). The velocities are normalized by the reference velocity in 10 m height in the undisturbed approaching flow.

For winds coming from south-east (132°) where the terminal lies upstream of the existing runway, a reduction in flow speed can be observed downstream of the terminal at the gateway and, to a lesser extent, also at the runway (Fig. 3.1 to Fig. 3.3). The percentage deviation of the planned state compared to the actual state for a height of 10 m and 30 m is shown in Fig. 3.4. This shows that the velocity changes in most parts of the existing runway are less than 10 %. Only in the middle of the runway, right behind the new terminal, there is velocity reduction of up to 35 % at a height of 10 m. This effect, however, decreases with increasing height. At a height of 30 m, the reduction in wind speed at the runway is around 20 % but only in an area about 50 m long.

For the direction 240° the wind is almost parallel to the existing runway. The results for this wind direction can be seen in in Fig. 3.5 to Fig. 3.7. A change in wind speed due to the new terminal can only be observed right at the gateway. In lower heights (10 m, 20 m) a reduction in wind speed is determined right in front of the new terminal. A slight increase can be observed at the northern corner at 30 m height.

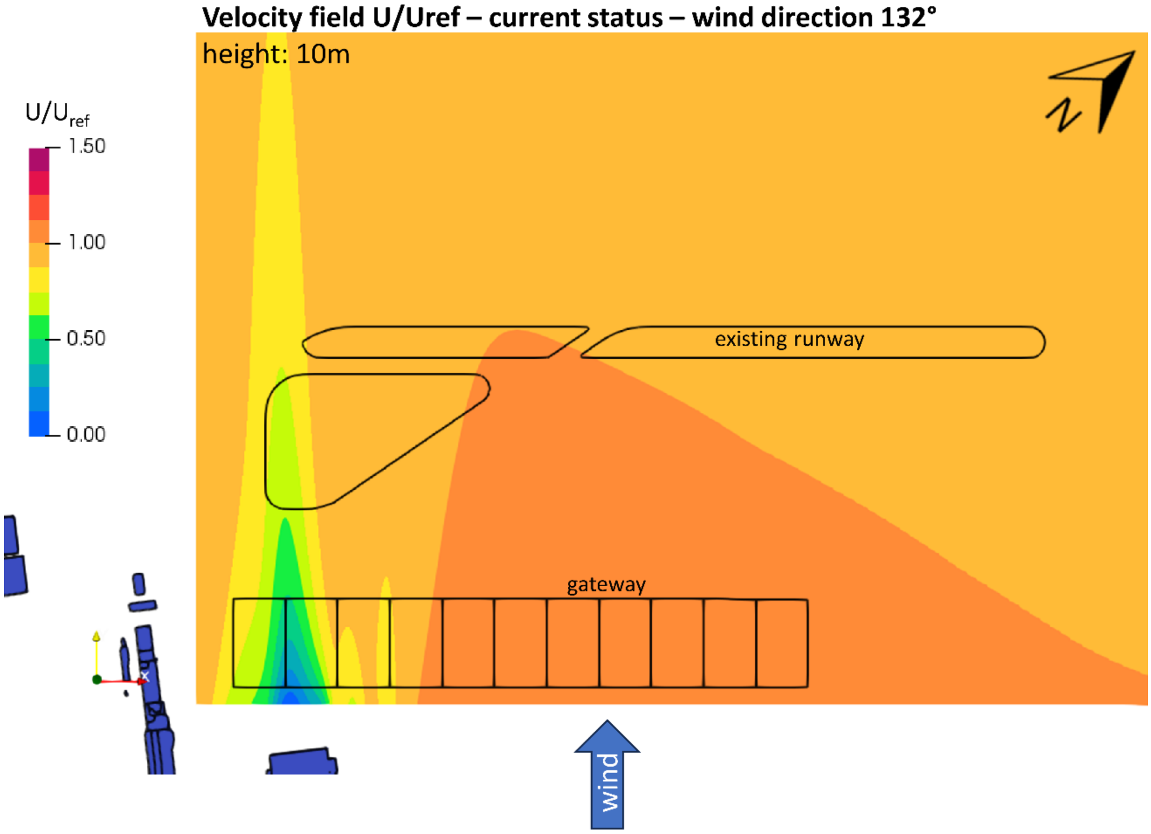
For winds coming from south-east to south-west where the new terminal lies windward of the runway, reduction in wind speed must be expected in a part of the existing runway. Depending on the wind direction, this area of reduced wind speeds can shift more towards left or right. The impact is highest close to the ground and decreases with increasing height.

For wind directions where the terminal lies leeward of the runway, an impact on the wind speeds is expected only close to the terminal building. Here, velocity reductions occur in front of the building and rather close to the ground, whereas local speed accelerations are expected in corner and edge regions of the building.

Impact on the new runway

The velocity changes due to the new building at the upper edge of the area displayed in the figures below is about 15 % at its maximum (wind direction 132°). This edge has a distance of about 600 m from the new terminal. The new runway is another 800 m further away in this direction (s. Fig. 2.3). The effect on the new runway for this wind direction is, thus, assumed to be negligible.

The shortest distance from the new terminal to the new runway is about 700 m for winds coming from south. Due to the distance the changes in wind speed are assessed to be 15 % or less. It should be noted, that this concerns the area at the far end of the runway. In the rest of the runway, the changes are assessed to be less due to the increasing distance.



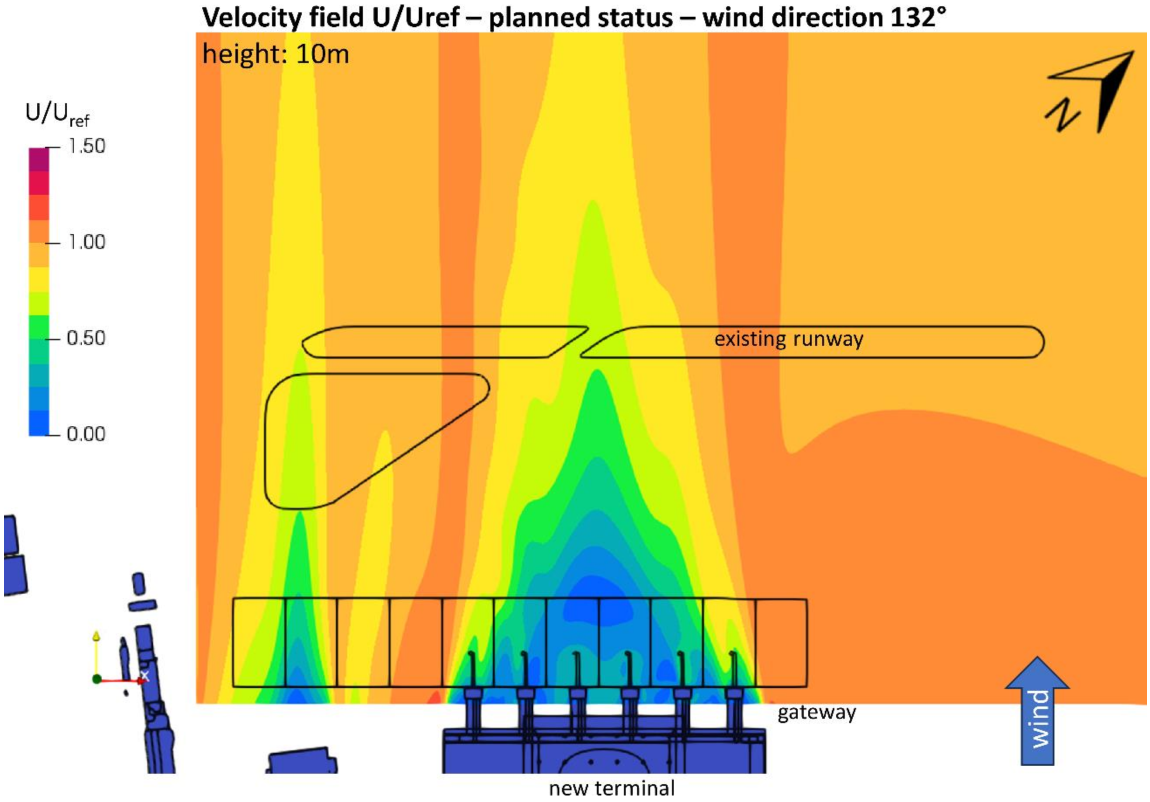
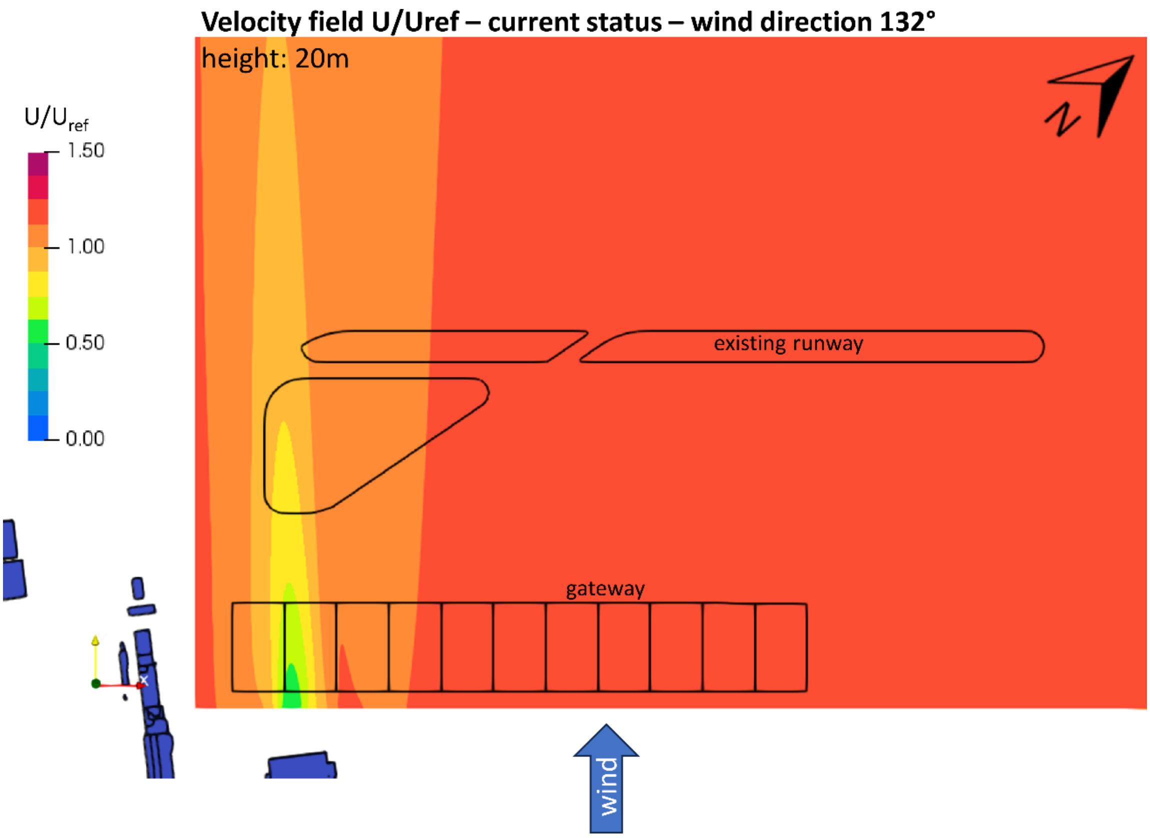


Fig. 3.1: Normalized velocity field (U/U_{ref}, U_{ref} = undisturbed velocity in 10 m) for the current status (upper figure) and planned status (lower figure)

Wind direction 132° - 10 m height



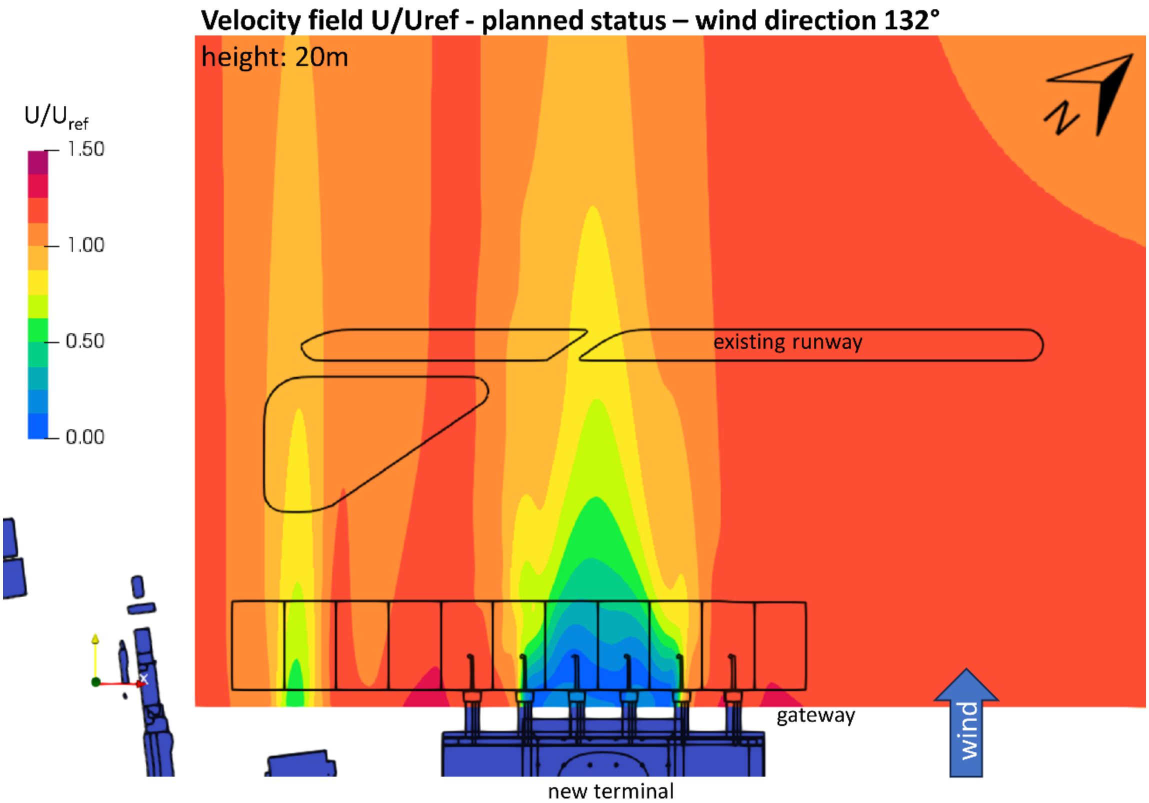


Fig. 3.2: Normalized velocity field (U/U_{ref}, U_{ref} = undisturbed velocity in 10 m) for the current status (upper figure) and planned status (lower figure)

Wind direction 132° - 20 m height

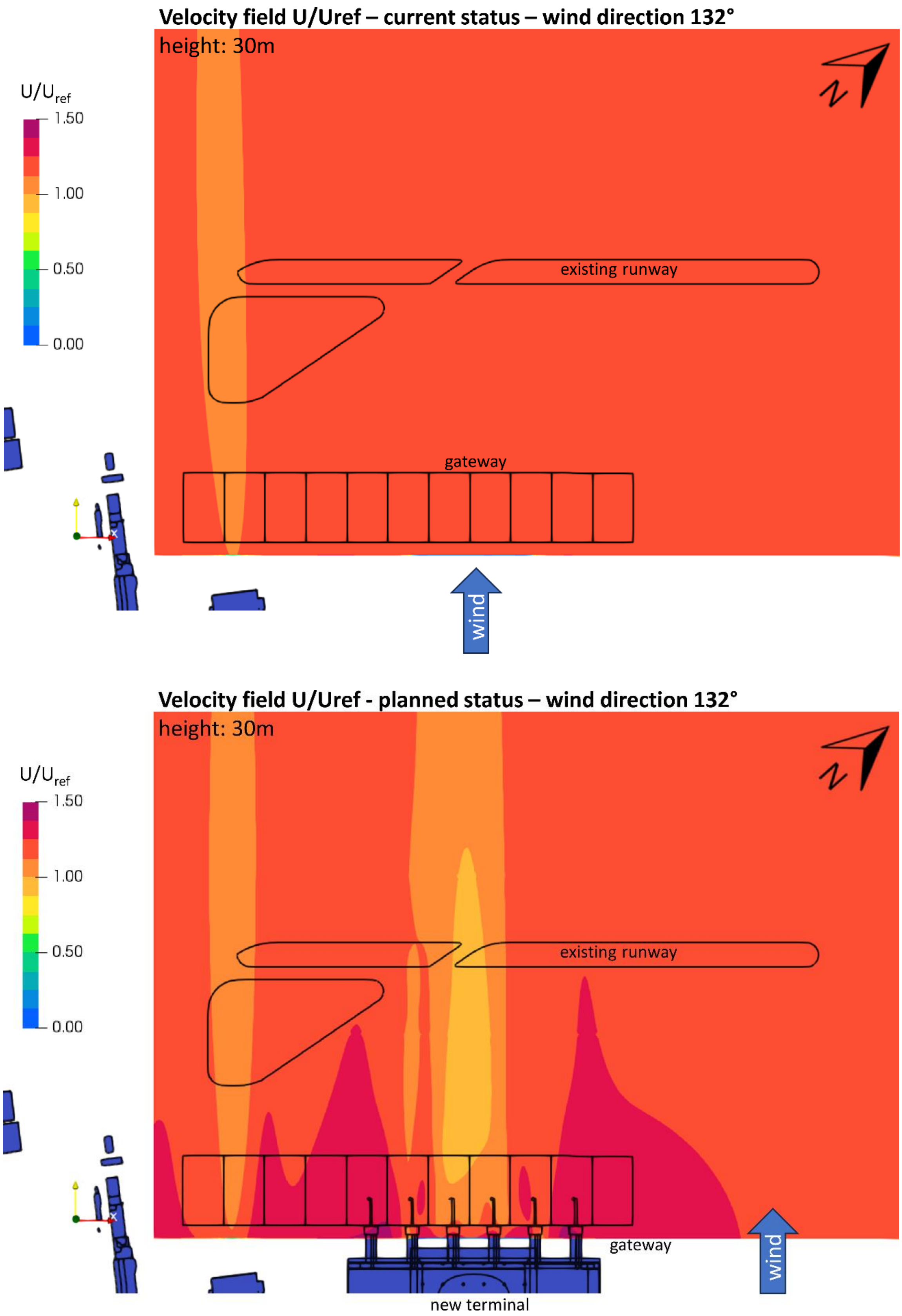


Fig. 3.3: Normalized velocity field (U/U_{ref}, U_{ref} = undisturbed velocity in 10 m) for the current status (upper figure) and planned status (lower figure)

Wind direction 132° - 30 m height

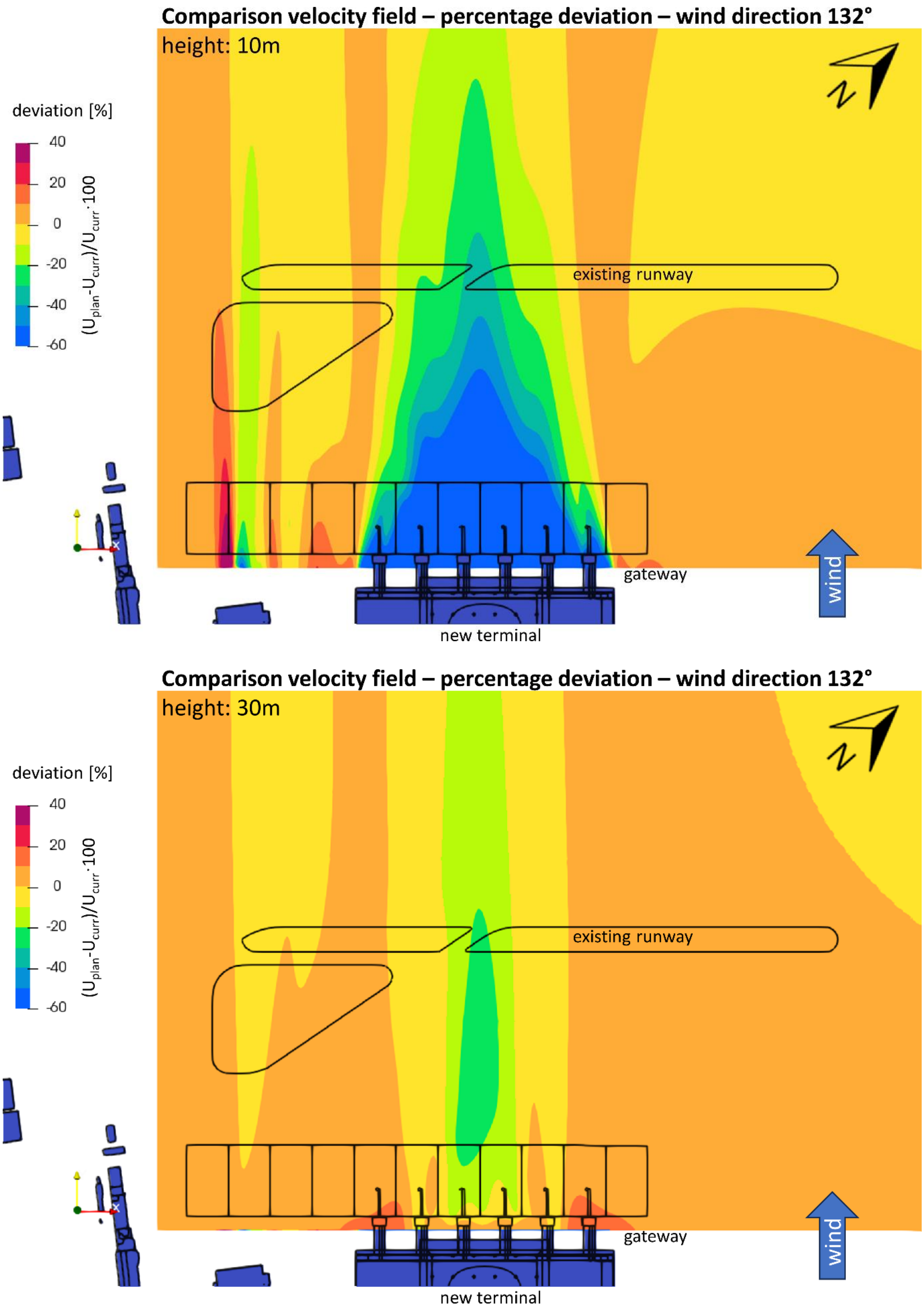


Fig. 3.4: Percentage deviation of the mean velocity in the planned status compared to current status (positive values mean increase of the velocity due to the new terminal), upper figure: 10 m height; lower figure: 30 m height

Wind direction 132°

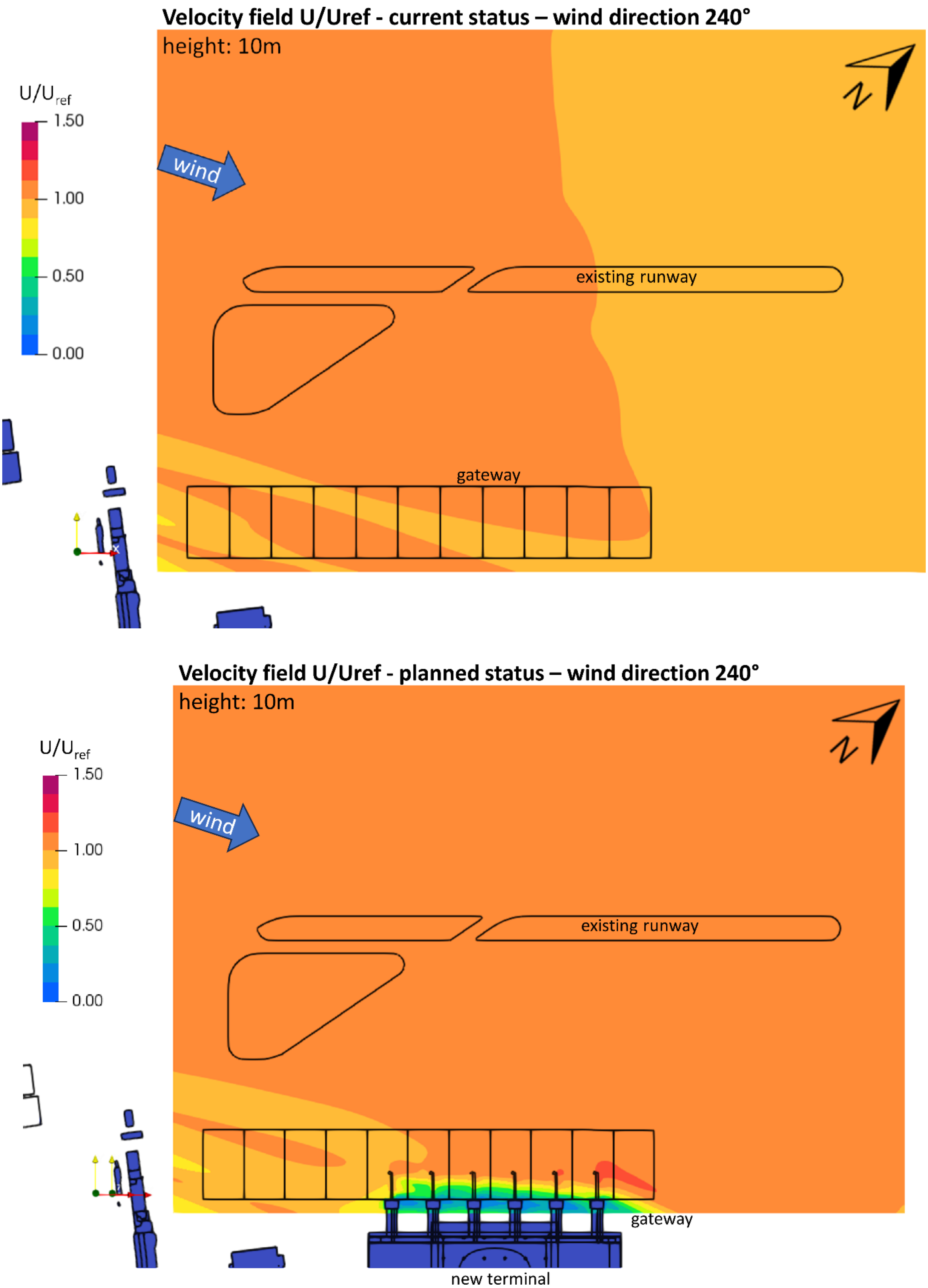
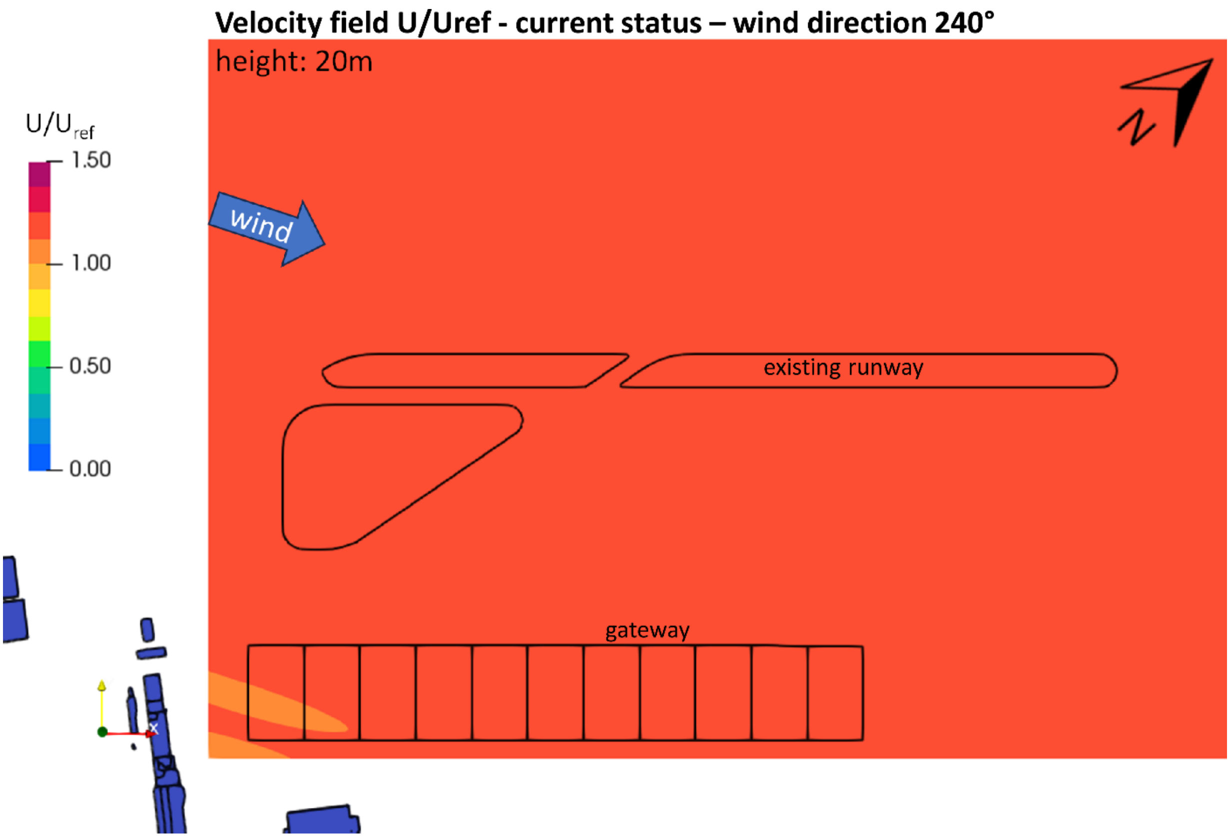


Fig. 3.5: Normalized velocity field (U/U_{ref}, U_{ref} = undisturbed velocity in 10 m) for the current status (upper figure) and planned status (lower figure)

Wind direction 240° - 10 m height



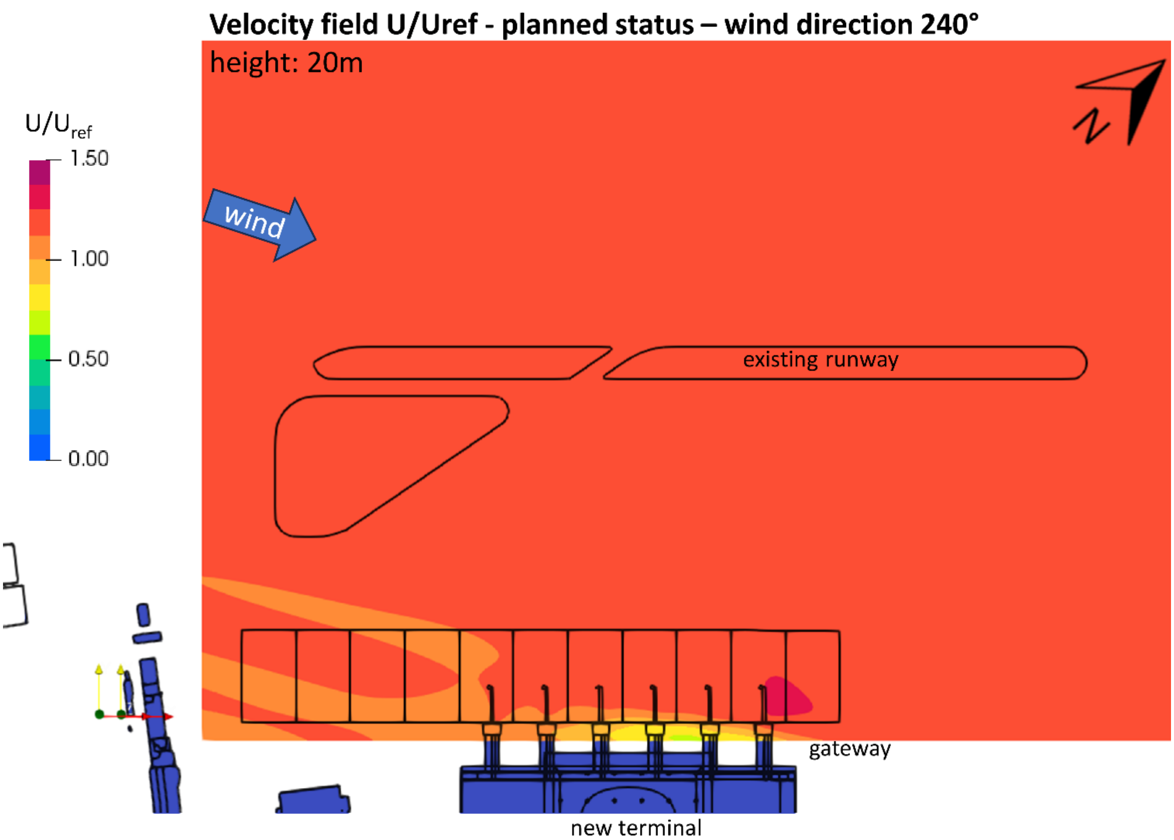
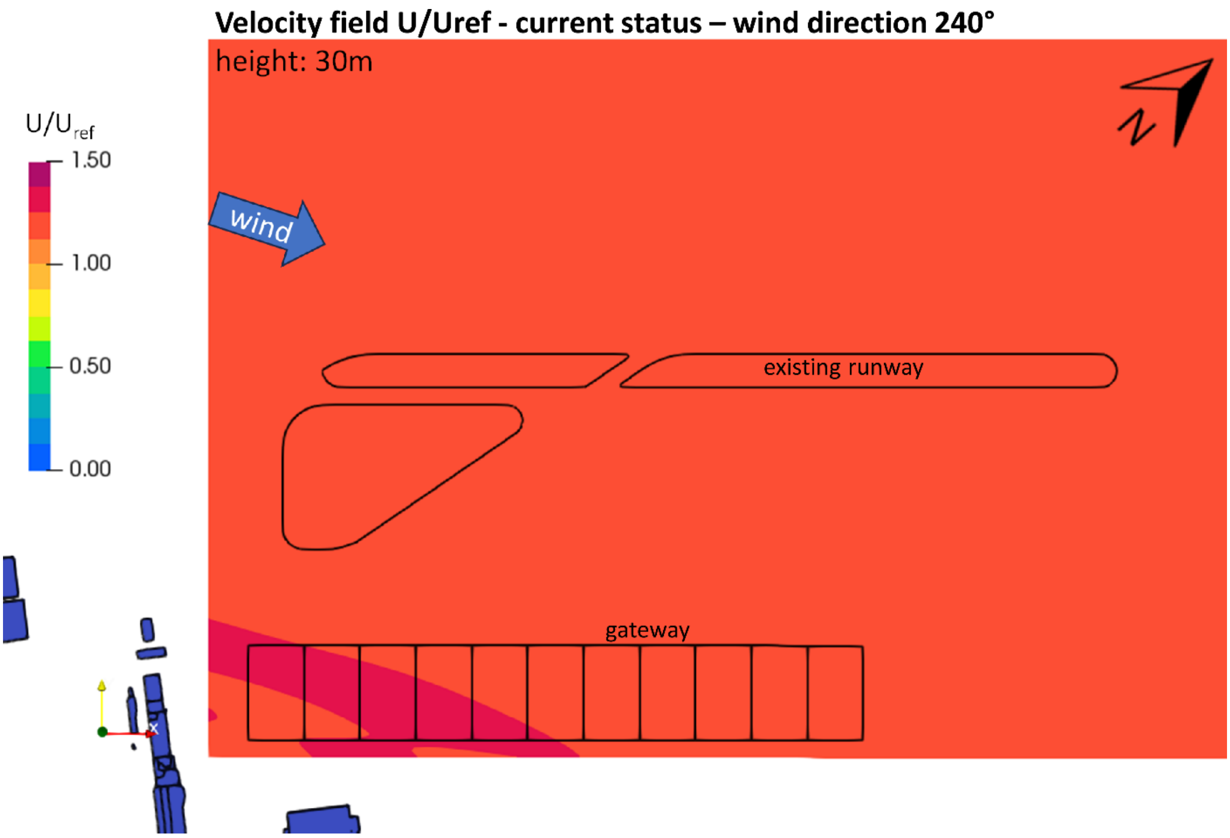


Fig. 3.6: Normalized velocity field (U/U_{ref}, U_{ref} = undisturbed velocity in 10 m) for the current status (upper figure) and planned status (lower figure)

Wind direction 240° - 20 m height



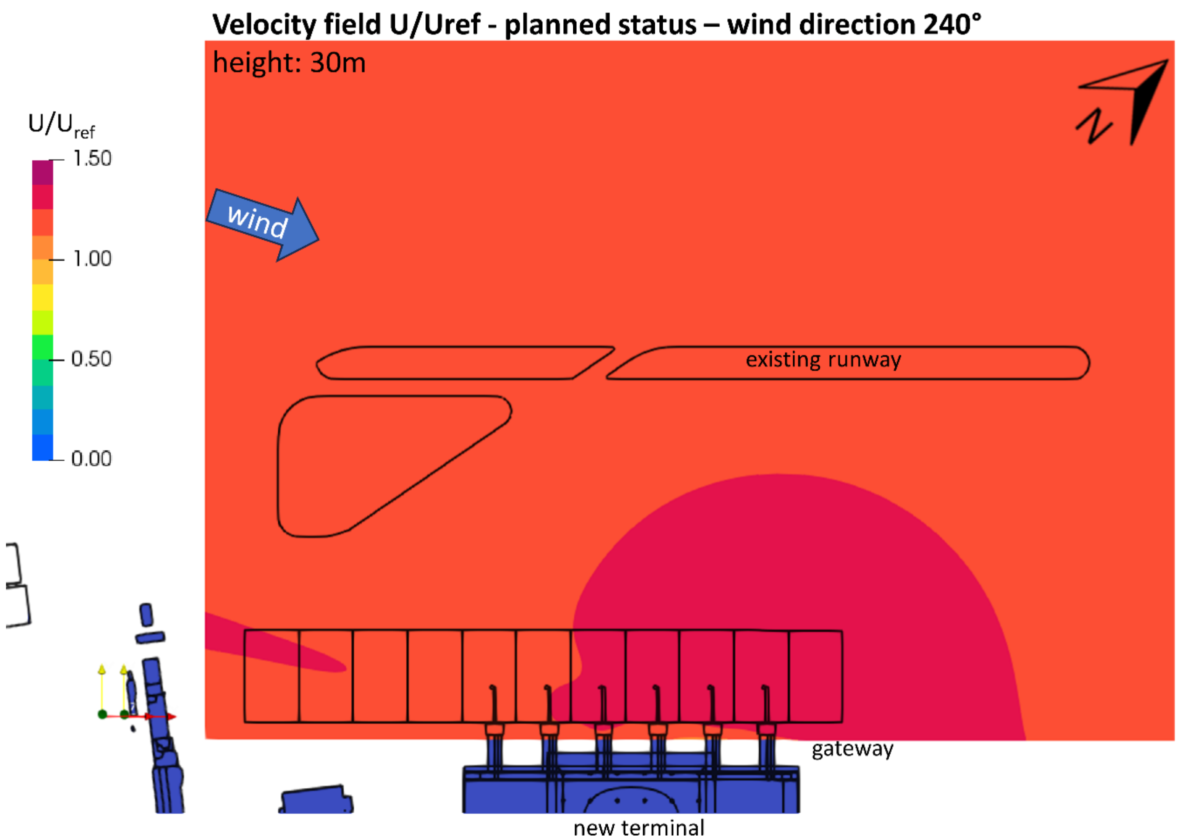


Fig. 3.7: Normalized velocity field (U/U_{ref}, U_{ref} = undisturbed velocity in 10 m) for the current status (upper figure) and planned status (lower figure)

Wind direction 240° - 30 m height

4 Documents

EN 1991-1-4, 2010: Eurocode 1: Actions on structures – Part 1-4: General actions – Wind actions.

RVA, 2023: “Planning documents, information, communication on the new Terminal at Florence Airport, Italy“, Rafael Vinoly Architects, New York, United States.