

Koninklijke Bibliotheek
Nationale bibliotheek van Nederland
Prins Willem-Alexanderhof 5
2595 BE Den Haag
www.kb.nl

New building National Library Den Haag, Storage Facility

Project Definition / Functional Specification part 1 & 2

Requirements Construction, Construction Infrastructure, Logistics Infrastructure

Impressum

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1 Concept Description

1.1 Origin of the project

The Koninklijke Bibliotheek in Den Haag has been accommodated in its actual building for many years. The library as well as its entire logistics services are situated in this building.

The building is in need of an extensive renovation. At the same time there is not nearly enough space to satisfy current and future needs.

The investigation into the renovation possibilities and the feasibility studies and cost calculations for a new, semi-automated storage facility led to the decision to search for other locations for all logistic services as well as for the library itself. According to the current state of planning, the library and the logistic services will be realized at different locations.

The following explanations and specifications refer to the logistics services building.

1.2 Project idea

The off-site storage facility consists of a storage part and an administration and logistics services part; the building will have the design of a functional and appropriate industrial building.

The storage facility is planned as a high-bay shelving storage with partly automated storage management; it should be extensible with identical storage modules. The building envelope has to fulfil high requirements concerning air-tightness, interior climate, and fire prevention.

The administration and logistics services part of the building serves to handle logistical tasks, like ingesting, controlling, and preparing books and serials for delivery, and it offers workshops and offices for the administration, for dedusting, document delivery, repair work, and space for technical infrastructure and facility management.

These specifications are based on the planning process of the Koninklijke Bibliotheek that has been started in June 2017 (status January 2019). They also profit from the experiences acquired in the planning and realization process of the Cooperative Storage Library Switzerland in Büron which is similar in many respects but not identical.

- Annex 1: Layout plan of the plot and concept for the situation of the building and for accessibility*
Annex 2: Layout storage area
Annex 3: Layout administration and logistics part of the building

2 Space Programme

2.1 High bay storage area, 1st phase: 5.2 million items

Basic installation high bay storage shelving:

9 alleys for containers / bins

2 alleys for pallets / pallet boxes

measurements with internal escape corridor: (L x W x H)

inside: 70,5 x 44,5 x 19,2 m (L x W x H) from level +/- 0

outside: 71,5 x 45,5 x 19,5 m (L x W x H) from level +/- 0

measurements without internal escape corridor (11 doors): (L x W x H)

inside: 69,0 x 44,5 x 19,2 m (L x W x H) from level +/- 0

outside: 70,0 x 45,5 x 19,5 m (L x W x H) from level +/- 0

The goods lift needs an additional vertical overhang of ca. 1.7 m.

The erection of a photovoltaic installation on the roof is not contained in these measurements.

These measurements are to be checked and verified with the selected firms when planning the construction in detail.

2.2 Administration and logistics services area of the building

5 floors from the ground floor to the 4th floor

measurements with internal escape corridor (and 2 doors from it to the outside) in storage area: (L x W x H)

inside: 70,5 x 9,0 x 19,2 m from level +/- 0

outside: 71,5 x 9,5 x 19,5 m from level +/- 0

measurements without internal escape corridor (and 11 doors to the outside) in storage area: (L x W x H)

inside: 69,0 x 9,0 x 19,2 m (L x W x H) from level +/- 0

outside: 70,0 x 9,5 x 19,5 m (L x W x H) from level +/- 0

The goods lift needs an additional vertical overhang of ca. 1.7 m.

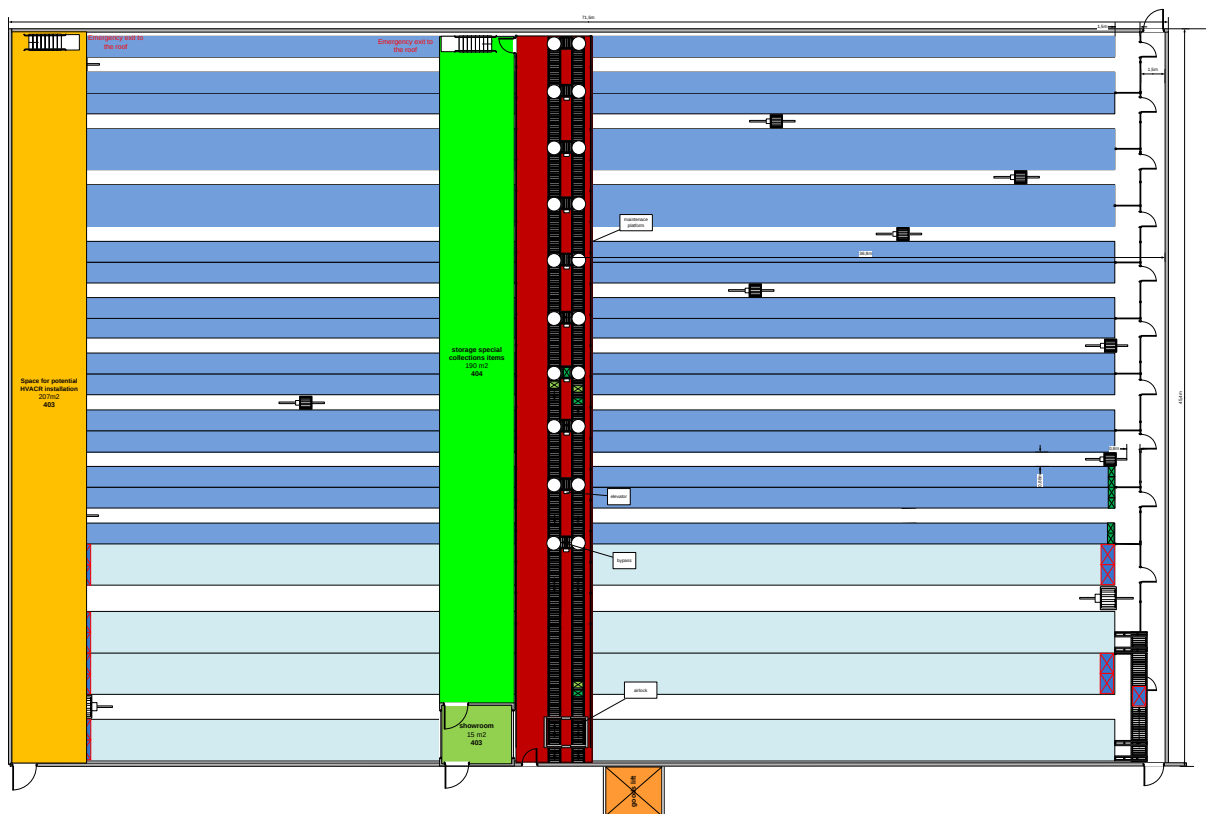
2.3 Functional spaces overview

Please check the detailed list 'Functional Spaces KB', annex 4.

Annex 4: Functional Spaces KB

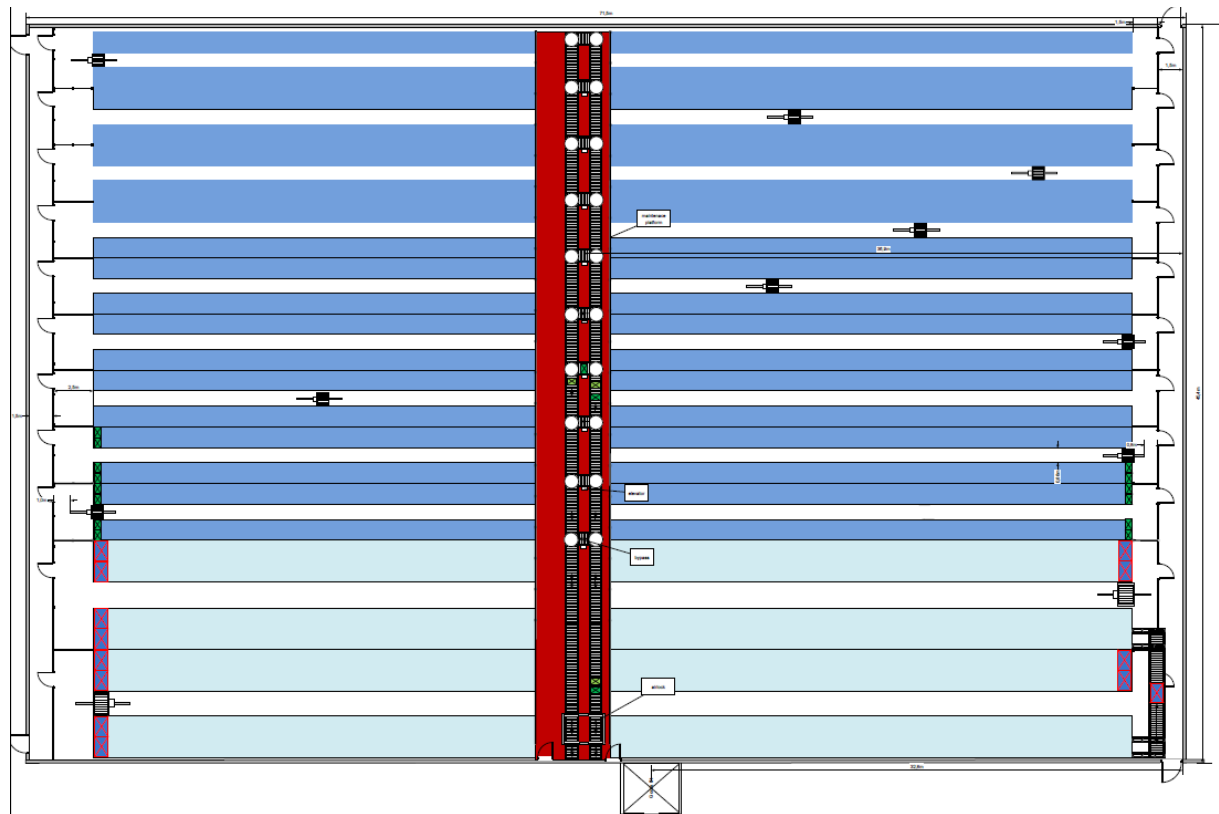
2.4 Floors/levels and rooms of the storage area

2.4.1 Level above storage shelving



Room number	Description	floor space required						requirements			relation to another room		description / remarks requirements
		m2						climate	day light	finishings standard L = logistics O = office M = machine			
		GF	1st F	2nd F	3rd F	4th F	storage					function	
403	Space for potential HVACR installation						207	storage condition	no	M		Space for potential HVACR installation	room reserved for potential HVACR installations (air conditioning, humidification etc.), no oxygen reduction
404	showroom						15	storage condition	no	L	405	showroom for high bay storage	showroom for visitors etc., no oxygen reduction
405	storage special collections items						190	storage condition	no	L	404	storage special collections items, for rolled or horizontally stored big size items (like plans, posters etc., and folio+ formats)	inside oxygen reduction area

2.4.2 Ground level storage shelving



The internal escape corridor is not necessary.

Measurements without internal escape corridor (i.e. 11 doors to the outside): (L x W x H)

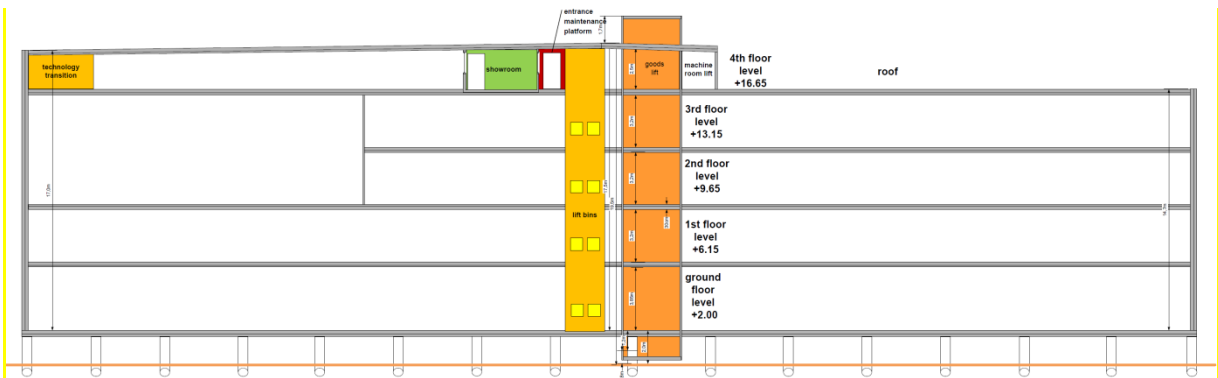
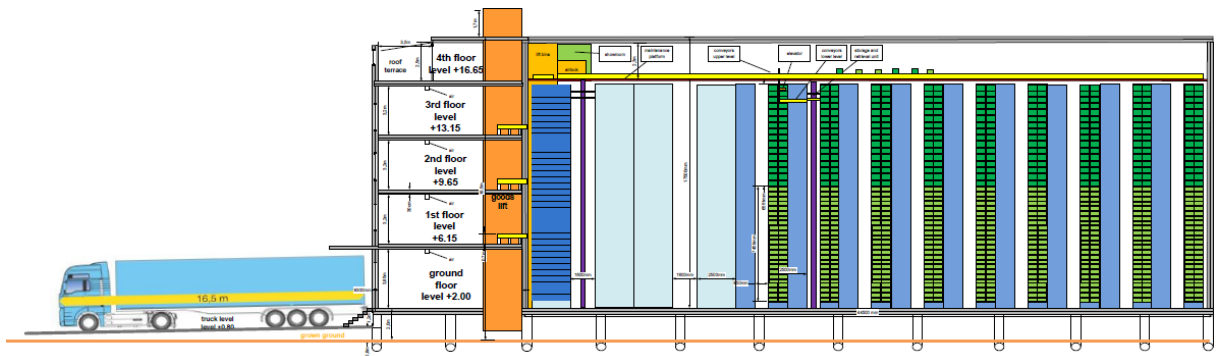
inside: 69,0 x 44,5 x 19,2 m (L x W x H) from level +/- 0

outside: 70,0 x 45,5 x 19,5 m (L x W x H) from level +/- 0

Details for the conveyor belt system layout for pallet boxes see point 2.6.2 and 5.1.2.2

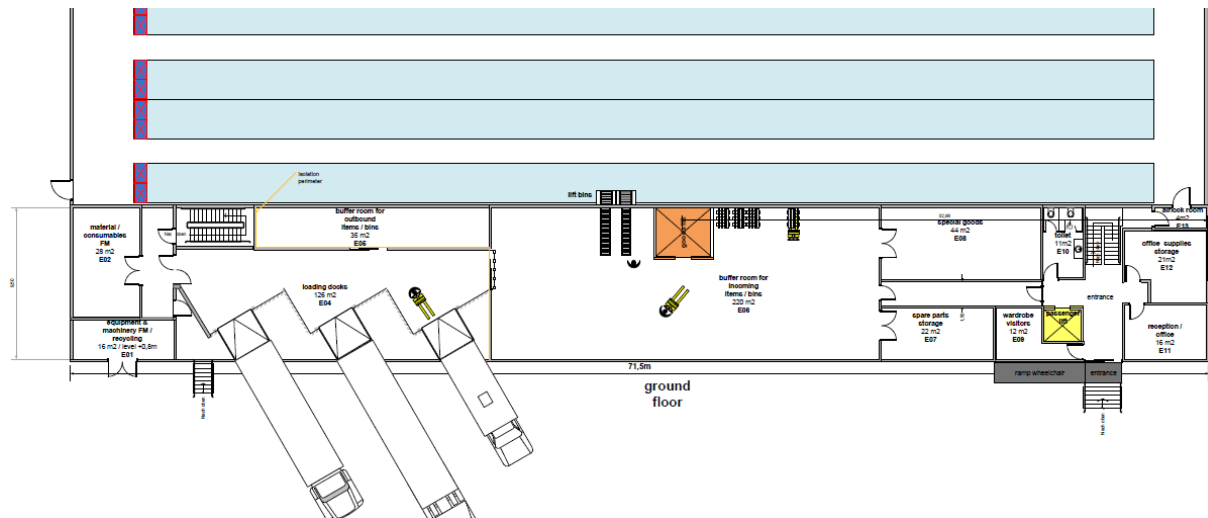
Room number	Description	floor space required						requirements			relation to another room	function	description / remarks / requirements
		GF	1st F	2nd F	3rd F	4th F	storage	climate	day light	finishings standard L= logistics O= office M= machine			
406	high bay warehouse						3137 / 3070	storage condition	no	L	105 / 204 / 302	automatic high bay warehouse for bins and pallets	oxygen reduction

2.5 Sections



2.6 Floors and rooms of the administration and logistics services area

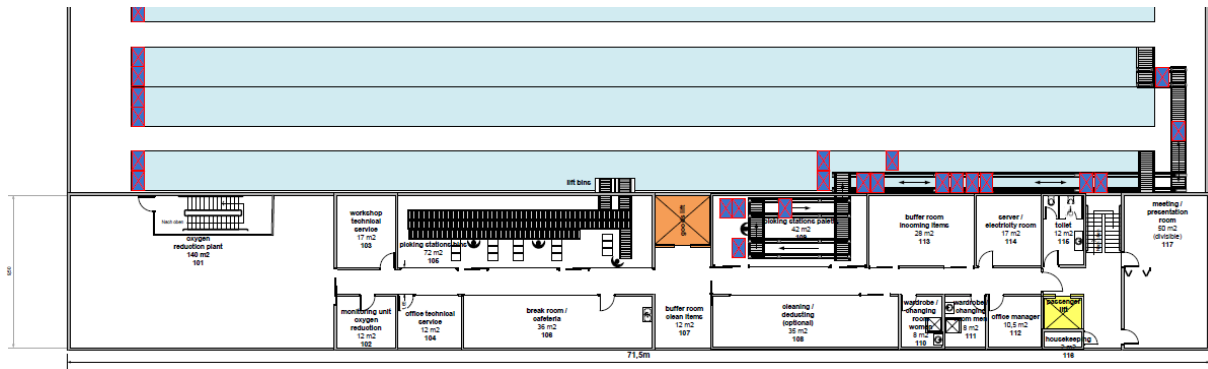
2.6.1 Ground floor



Room number	Description	floor space required						requirements			relation to another room	function	description / remarks / requirements
		GF	1st F	2nd F	3rd F	4th F	storage	climate	day light	finishings standard L = logistics O = office M = machine			
E01	equipment & machinery FM / recycling	16						no heating / ac	no	L		storage equipment & machinery FM / recycling Level +0.80	room for storage of FM equipment and machinery for care and maintenance of tarmac etc. and surroundings / room for waste and recycling containers
E02	material / consumables FM	28						no heating / ac	no	L	E04	storage material facility management	storage room for material FM (cleaning supplies and consumables)
E04	loading docks	126						no heating / ac	yes	L	E05 / E06	deliveries in and out	3 different loading docks types: 1 normal truck/lorry dock, 1 dock with a sliding section and level adjustment 60-120 cm, 1 lifting station 0 - 120 cm
E05	buffer room for outbound items/ bins	35						normal	no	L	E05	buffer room for the items/ bins prepared for loading	space and volume for carts and bins (ca. 50 % of daily delivery volume, i.e. ca. 220 orders per day) accessible from the outside for authorised drivers equipped with standard shelving for bins
E06	buffer room for incoming items/ bins	220						normal	no	L	E04 / E07 / E08	buffer room for incoming material (first ingestion, loan returns) exchange space for empty transport bins	accessible from the outside for authorised drivers
E07	spare parts storage	22						normal	no	L	E06	Storage for spare parts for the logistics infrastructure and HVACR	equipped with shelving for pallets and bins
E08	special goods	44						normal	no	L	E06	storage for furniture, paper, cardboard, binding materials etc.	equipped with shelving for pallets and bins
E09	wardrobe visitors	12						normal	yes	L	Entrance	wardrobe visitors	equipped with lockers and a coatrack
E10	toilet	11						normal	yes	O		toilet	
E11	reception / office	16						normal	yes	O	entrance / outside	reception / office	view to parking area and entrance to the grounds
E12	office supplies storage	21						normal	yes	L	E11	storage for office supplies	equipped with standard shelving and cupboards
E13	air lock room	4						normal	no	O	E14	air lock room	air lock between oxygen-reduced area and normal oxygen area

The ground floor is partitioned into an operative logistics services area, and an office and public area. It is divided as well into a cold zone (no heating/AC) and a zone with heating (cf. layout plan Administration and Logistics Services Section, ground floor, isolation perimeter).

2.6.2 1st floor



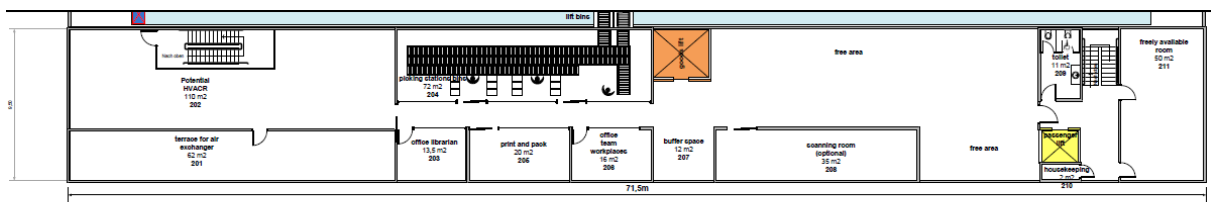
1st floor

Room number	Description	floor space required						requirements			relation to another room	function	description / remarks / requirements
		GF	1st F	2nd F	3rd F	4th F	storage	climate	day light	finishings standard L = logistics O = office M = machine			
101	oxygen reduction plant		140					normal	no	M	102 / 103	room for installation of Control devices for oxygen reduction	
102	monitoring unit oxygen reduction		12					normal	no	M	101		
103	workshop technical service		17					normal	no	L	101 / 103	workshop technical service	
104	office technical service		12					normal	yes	O		office for technical service	
105	picking stations bins		72					normal	yes	L	106 / 107	picking stations for bins in/out	
107	buffer room clean items		12					normal	no	L	105 / 108	buffer clean items	
108	cleaning / dedusting room (optional)		35					normal	yes	L	107	cleaning / dedusting	optional, depends on future concept and on location of cleaning
109	picking stations pallets		42					normal	yes	L	107 / 108	Picking stations for pallets in/out	
110	wardrobe / changing room		8					normal	yes	L		wardrobe / changing room	with shower and sink, and with lockers and a coatrack
111	wardrobe / changing room		8					normal	yes	L		wardrobe / changing room	with shower and sink, and with lockers and a coatrack
112	office manager		10,5					normal	yes	O		office manager	
113	buffer room incoming items		28					normal	no	L	105 / 108 / 109	buffer room incoming items	
114	server / electricity room		17					normal	no	L		server / electricity room	
115	toilet		12					normal	no	O		toilet	
116	housekeeping		2					normal	yes	L		housekeeping	room for storing housekeeping utensils
117	meeting / presentation room		50					normal	yes	O		meeting / presentation room	Divisible with folding wall (acoustics!) multifunctional equipment for meetings and presentations; kitchenette for coffee, tea etc., cupboard

The 1st floor is partitioned into an office and operative logistics services area, an HVACR area, and a public area.

If a maintenance platform is required for the pallet transport system, the storage bins can be locked in the WMS. The number of storage bins is reduced by 75 for the conveyors (included in the calculation) and 100 for the possible maintenance platform.

2.6.3 2nd floor

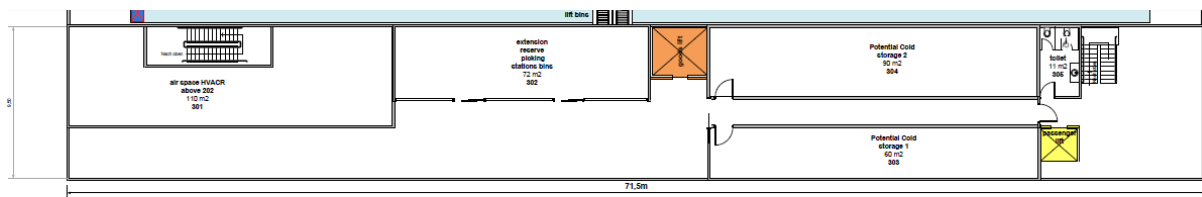


2nd floor

Room number	Description	floor space required						requirements				relation to another room	function	description / remarks / requirements
		GF	1st F	2nd F	3rd F	4th F	storage	climate	day light	finishings standard L = logistics O = office M = machine				
201	terrace for air exchange			62				outdoor					terrace for air exchanger	
202	Potential HVACR			110	110			normal	no	M			HVACR	heating, ventilation, AC, water, refrigeration, etc.
203	office librarian			13,5				normal	yes	O			office librarian (cataloging, etc.)	verifications, data curation, catalogue clarifications, etc.
204	Picking stations bins			72				normal	yes	L	207 / 208		picking stations for bins in/out	
205	print and pack			18,5				normal	yes	L			print and pack	central room for printing and packing
206	office team workplaces			13,5				normal	yes	O			office team workplaces	work spaces for all members of the logistics team
207	buffer space			12				normal	no	L	204 / 207		buffer space for items in/ out	
208	scanning room (optional)			35				normal	yes	O	204		scanning room (optional)	room for document delivery requests (scanning/ copying), optional, process is not yet defined
209	toilet			11				normal	no	O			toilet	
210	housekeeping			2				normal	yes	L			housekeeping	room for storing housekeeping utensils
211	freely available space			50				normal	yes	O			freely available space	

The 2nd floor is partitioned into an office and operative logistics services area, and an HVACR area.

2.6.4 3rd floor



3rd floor

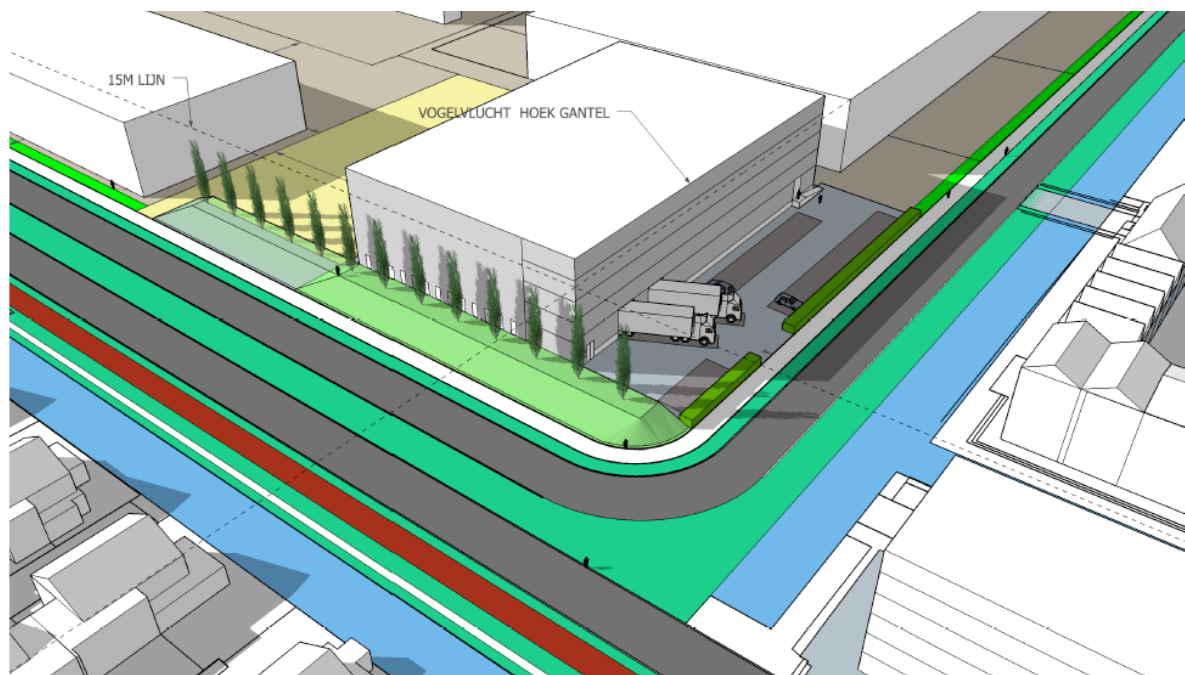
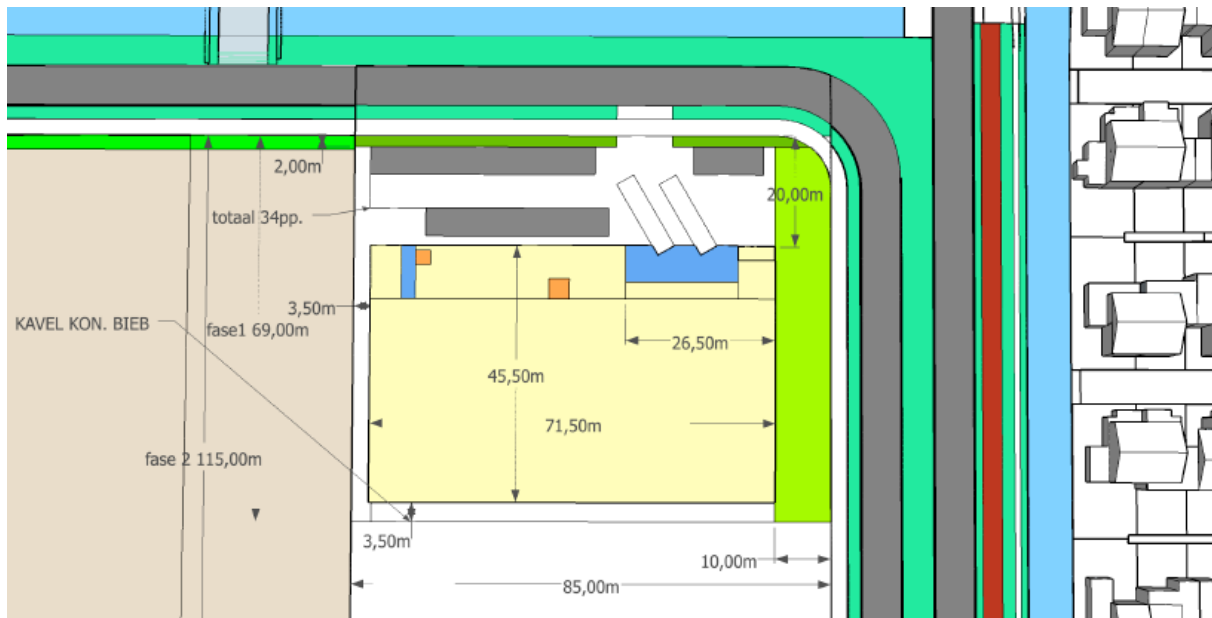
		floor space required						requirements			relation to another room	function	description / remarks / requirements
Room number	Description	m2						climate	day light	finishings standard L= logistics O = office M= machine			
		GF	1st F	2nd F	3rd F	4th F	storage						
301	air space HVACR above 202				110			normal	no	M	202	air space HVACR	no floor, directly above, and part of 202
302	extension reserve, picking stations bins				72			normal	yes	L		extension reserve, picking stations bins	
303	Potential Cold storage 1				60			active ac / cooling	no	L	304	cold storage 1	actively cooled room for films, microfilm etc. 4-12 degrees Celsius, 30 - 50 % RH
304	Potential Cold storage 2				90			active ac / cooling	no	L	303	cold storage 2	actively cooled room for films, microfilm etc. 4-12 degrees Celsius, 30 - 50% RH
305	toilet				11			normal	no	O		toilet	

The 3rd floor is reserved for finishing and extension at a later date as well as for two potential cold storage rooms. It is partitioned into an office and operative logistics services area, and an HVACR area.

2.7 Access / traffic concept

The access and traffic concept and the forecourt design all depend on the point of entry that will be selected, as well as on the neighbouring plots. – The forecourt should measure ca. 30 x 80 m.

Some 12 parking slots for employees and visitors will be needed from a current point of view.



3 Building and Infrastructure

3.1 Automated container storage

Construction of the shelving and the storage hall



The exact kind of supporting structure remains to be defined. Preferably the following types are to be examined in the detailed planning phase.

3.2 Type 1: Self-supporting hall (column-free)



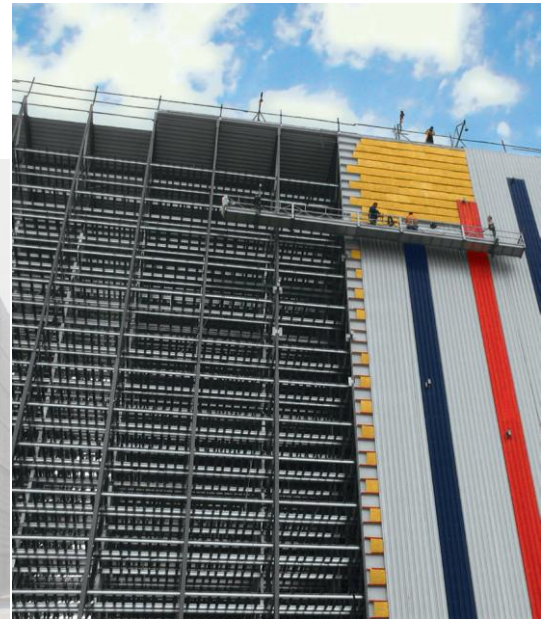
Strengths: Column-free space within a storage module; Short construction and finishing time for the building envelope; Detailed planning for the construction can be realized mostly independent from the supplier of the logistics infrastructure.	Weaknesses: Framework construction, thus a larger construction volume is needed; The building is higher because of the framework construction. This could be compensated by having the framework beams on the outside. But such a construction would exclude storage spaces above the shelving.
Opportunities: Detailed planning of the construction and evaluation of the logistics infrastructure offers can be done at the same time → an advantage as to the finishing date; Shorter realization period on the whole as the desiccation process for the building envelope takes place parallel to assembling and mounting the logistics infrastructure; The framework construction allows for the installation of an additional level and for spaces above the shelving.	Threats: Potentially higher construction costs in comparison to type 3.

3.3 Type 2: Hall with its own supporting construction with columns



Strengths: Optimized building volume, optimized height (no framework construction, girders or trusses as supporting structure of the roof); Short construction and finishing time for the building envelope.	Weaknesses: Column grid pattern must be coordinated very closely with the supplier of the logistics infrastructure → an early supplier evaluation decision is mandatory!
Opportunities: Shorter realization period on the whole as the desiccation process for the building envelope takes place parallel to assembling and mounting the logistics infrastructure; The framework construction allows for the installation of an additional level and spaces above the shelving.	Threats: Overall realization time is too long, as detailed construction planning has to be coordinated completely with the system of the logistics infrastructure → supplier has to be appointed before detailed construction planning can start. Potentially higher construction costs im comparison to type 3.

3.4 Type 3: Hall with the shelving system as supporting structure (silo structure)



Strength: Optimized use of space and volume.	Weakness: As the construction of the roof and the façade takes place only after the installation of shelving structure, the desiccation process can start only with the finished building envelope. This leads to a prolongation of the construction time as a whole.
Opportunities: Optimized costs.	Threats: Overall realization time is too long, as detailed construction planning has to be coordinated completely with the system of the logistics infrastructure → supplier has to be appointed before detailed construction planning can start.

3.5 Recommendation

On the basis of my experience with similar projects, I would recommend to choose construction type 1. It allows to have additional storage space for special collection oversize items within the oxygen reduced area, and it reduces construction and desiccation time.

4 Requirements for the Building and the Spaces

4.1 Legal regulations and standards

Current legal regulations and standards have to be observed.

4.2 Flexibility of the building

A building is subjected to change during its life cycle because of new or changing organization structures, new insights into work processes, new technology etc. The flexibility of a building therefore is an important prerequisite for guaranteeing optimal use potential during its complete life cycle:

- systematic partitioning: Definition of building elements with different life cycles. Definition of primary, secondary, and tertiary elements as provided below:

		Strategic life expectancy
Primary elements (are long-term investments and cannot be changed)	Logistics infrastructure – construction, outside / plot / building: • development • traffic • energy	50-100 years
	supporting structure: • supporting framework vertically and horizontally	50-100 years
	logistics infrastructure – construction, inside: - infrastructure spaces - storage logistics - horizontal and vertical access within the building	30 years
	building envelope: - façade / windows - roof	30-40 years
Secondary elements (are medium-term investments; they are adaptable which ensures variability)	Internal finish: - layout / constructional design logistics infrastructure – equipment: - high bay shelving / robots / conveyor belt systems	20-30 years
	finishing: surfaces - walls - ceilings - floors	15-20 years
	HVACR and domestic engineering: - distribution / supply grid - production / machinery - lighting - oxyreduct plant - conveyor belts, robots	30-40 years 15-20 years 10-15 years 20 -30 years
Tertiary elements (are short-term investments that can be changed without major constructional changes: thus flexibility is ensured)	means of communication / IT finishing / furniture	5-10 years 10-15 years

Storage area:

- modular extensibility concerning building and engineering

Administration and Logistics Services area:

- layout flexibility
- preferred room heights – clear dimensions: ground floor: 330 cm, 1st to 3rd floors: 270 cm, and 4th floor: 250 cm

4.3 Statics

The statics of the building must conform to current standards for loadbearing structure systems. The earthquake resistance of loadbearing and non-loadbearing building elements pursuant to the building owner's requirements have to be guaranteed.

The imposed loads have to be planned corresponding to current norms; they must allow the following minimal values:

Room use	Load bearing capacity	remarks
access / forecourt	30 kN/m ² (3000 kg/m ²)	delivery trucks/lorries
high bay storage area	60 kN/m ² (6000 kg/m ²)	
administration and logistics services area:	5 kN/m ² (500 kg/m ²)	
delivery / ramp area	5 kN/m ² (500 kg/m ²)	
offices and meeting rooms	5 kN/m ² (500 kg/m ²)	

The use requirements are to be defined in the occupancy and use agreement.

4.4 Floor and walls structure

The floor structure has to correspond to statics specifications and climate requirements. Furthermore finishing wishes are to be respected, especially for floor coatings in the administration and public areas.

The floor structure in the administrations and logistics services area should aim for as dust-free a daily use as possible.

The floor structures listed in the following table have been successfully used in similar projects; they can serve as a guideline:

Requirements for the floors		Remarks
Floor ground floor		to match with statics calculations, and requirements for flood protection
cement coating	50 mm	
in situ concrete	250 mm	
loose fill with Misapor / insulating material	50 mm	
lean concrete	100 mm	
Floor 1st floor		
false or floating ceiling	500mm	
cement coating	50 mm	
in situ concrete	250 mm	
loose fill with Misapor / insulating material	50 mm	
lean concrete	100 mm	
Floor 2nd floor		
false or floating ceiling	500mm	
cement coating	50 mm	
in situ concrete	250 mm	
Floor 3rd floor		
false or floating ceiling	500 mm	
cement coating	50 mm	
in situ concrete	250 mm	
Floor 4th floor		
false or floating ceiling	500 mm	
cement coating	50 mm	
in situ concrete	250 mm	
Floor storage area		to match with statics calculation, requirements for flood protection, and selected load bearing construction
granolithic concrete	50 mm	
in situ concrete	500 mm	
loose fill with Misapor / insulating material	50 mm	
lean concrete	150 mm	
Roof (outside)		to match with selected load bearing construction (see chapter xxx)
green roof, with extensively planted greenery	120 mm	
seepage bed	20 mm	
bitumen waterproofing membrane	20 mm	
polymer bitumen	20 mm	
concrete on a trapezoidal hollow rib metal sheet, with a downward slope of 1.5 %	120 mm	
steel beam	200 mm	
triangulated steel framework		

Walls storage area		to match with statics calculations and climate requirements
Corten steel sheets (or other exterior façade)	175 mm	trapezoidal sheet
back ventilation		
isolation rock wool	80 mm	
concrete (eg prefabricated filled sandwich elements)	360 mm	
interior air-tightness paint coat Polymer		
walls administration and logistics services area		
Corten steel sheets (or other exterior façade)	175 mm	
back ventilation / Unterkonstruktion	100 mm	
isolation rock wool	200 mm	
concrete / masonry	200 mm	

Annex 5: floor and walls requirements

4.5 Energy and HVACR concepts

Dutch standards and norms for low energy consumption buildings are to be met. Machinery and lighting of the best energy efficiency class should be obtained.

Equipment that has to run without interruption has to be protected with corresponding redundant systems. Contingency plans for interruptions or stoppages of critical elements have to be defined.

4.5.1 Climate conditions

Comfort requirements will be fulfilled primarily through construction solutions and optimized operations. HVACR machinery should have a complementary function only.

Use	Climate requirements	remarks
Administration area (normal):	18 -23 °C room temperature, 30-60 % RH	at night down to 16 °C
offices		
reception and waiting areas		
meeting room >6 persons		
break room		
copy, scan and printing room		
toilets		
corridors, staircases		
buffer rooms		
Supply rooms		
Administration area (no heating):	No heating / ac	
housekeeping rooms		
loading docks		
machinery, FM, recycling		
Storage area	10 °C – 22 °C	max difference +/- 1 °C within 12 h
	40 - 55 % RH	+/- 5 % within 48 h; air filtering is important
	13 % oxygen content	Fire prevention = oxygen reduction
Cold storage	4 - 12 degrees Celsius, 30 - 50 % RH	
	active ac / cooling	

The passage for bins from the storage area to the administration and logistics services area takes place with a conveyor belt system and has to be fitted with locks for climate, fire prevention, and oxygen reduction.

A monitoring system is to be installed that functions separately from the BMS:

- T
- RH / AH
- dewpoint
- VOC's
- dust
- fungal spore air sampling

4.5.2 Operating hours during the heating period

Maximum operating times have been defined for the administration and logistics services area: Monday to Friday 07:00 to 20:00, Saturday 07:00 to 16:00. It is possible to extend these operating times in order to allow deliveries on Sunday.

These operating times can be extended up to 24/7 during the period of the first ingestion.

During operating hours room temperatures have to meet the values indicated in the table above (cf 4.5.1). Outside of the operating hours, on weekends and on holidays, room temperatures can be lowered (switch off heating or lower flow temperature), as long as the basic structural-physical parameters are met.

As a rule, room temperature should not fall below 16 °C.

4.5.3 Thermal protection during summer

Attention should be paid to thermal protection during summer; a building should remain thermally comfortable even on heat days (outside temperature > 30 °C).

Planning should be based on the following principles:

- minimizing internal heat loads by using energy efficient electrical devices and lighting;
- realize procedures for an effective cooling during the night :
 - have windows or other openings in the façade that can stay open in the night; should rain or heavy winds occur, they should either close automatically or be constructed in a way that they can remain open.
→ This has to be planned in combination with an intrusion detection and prevention system
 - air flow in the building should be planned to use thermal uplift (stack-effect).
- Active air conditioning should not be used. Exceptions could be possible for rooms with special requirements as e.g. server rooms, cold storage rooms or, if need be, the storage area.
- Movable sun protection mounted outside, e.g. roller shutters or venetian blinds (energy transmittance value, g-value, max. 0.1).

4.5.4 Ventilation concept

Requirements concerning hygiene, relative humidity, and necessary air changes have to meet current norms and standards.

4.5.5 Fire prevention / emergency exits

The pertinent fire prevention regulations have to be met.

The principal aim of fire prevention requirements is minimizing any danger to persons. In this special project, the most important aim for the storage area is the optimal protection of the stored goods. This is achieved with the oxygen reduction which prevents any fire although there are potential ignition sources.

The supporting framework has to be realized according to current framework norms.

The smoke and heat exhaust installation has to match the fire prevention system used.

Emergency exits have to be realized according to current norms and regulations.

4.5.6 Noise control

Outside noise

Compliance with minimal levels of current norms and regulations concerning noise is required. A need for values above minimal levels will be examined only when there are specific user needs.

4.5.7 Shadowing and screening

Shadowing installations have two main functions (which can be achieved with one single or two different systems):

1. sun protection: prevent overheating of a room;
2. glare protection: prevent glare caused by the sun.

Some user requirements are in opposition to this:

- optimal usage of day light;
- use of passive sun energy in winter;
- wish of the users to see outside.

Sun and glare protection are to be achieved exclusively with motorized outside shutters or blinds. They have to be controlled for each room. Controls must be possible for groups of rooms (floors etc.).

Control of shadowing must be possible per orientation of building parts and esp. the façade. It should be possible to override the automation of shadowing manually at any time, even during an automated movement.

There are no curtains planned on principle. Curtains will be mounted only in a situation where a screen is necessary, e.g. on the ground floor where there is foot traffic immediately outside.

4.5.8 Barrier-free construction

Barrier-free construction is realized in new buildings on principle and in compliance with current norms and regulations.

4.5.9 Materials used

Ecological sustainability has a high priority in the concept and the construction, and in selecting products. Materials used should allow an easy and economical application with a low maintenance factor.

No gaseous emissions or diffusions and no material transmissions are to occur in the storage rooms.

A good quality for all workplaces should be ensured through using low-pollutant, ecologically compatible materials for interior rooms.

5 Logistics Infrastructure

The following remarks are supposed to give an overview of the logistics infrastructure and its energy demand. The detailed requirements are part of the functional specifications 'logistics infrastructure'.

5.1 Storage and conveyor infrastructure

5.1.1 Shelving and storage and retrieval units

Shelving and storage and retrieval units are used for bins as well as for pallets. Both types are limited to their respective alleys.

No sprinklers and no smoke detectors are installed in the shelving.

5.1.1.1 Shelving for bins

Bin measurements:

Type 1 outside 400 x 600 x 266 mm, inside 366 x 566 x 250 mm

Type 2 outside 400 x 600 x 371 mm, inside 366 x 566 x 355 mm

Double-deep storage on angle irons in the shelving

max. weight is 60 kg per bin, average 48 kg.

number of bins Type 1: 114'912

number of bins Type 2: 76'608

5.1.1.2 Shelving for pallet boxes

Dimensions

pallet boxes measurements



Type 3 outside 800 x 1150 x 300 mm, inside 748 x 1040 x 283 mm inside

number of boxes: approximately 24'000

This box is created from two standard size bins. KB needs boxes with inside height 250 mm. At the moment, these are not standard.

Double-deep storage on angle irons in the shelving

max. weight is 110 kg per box.

Annex 8: *drawing bins Type 1*

Annex 9: *drawing bins Type 2*

5.1.1.3 Storage and retrieval units for bins

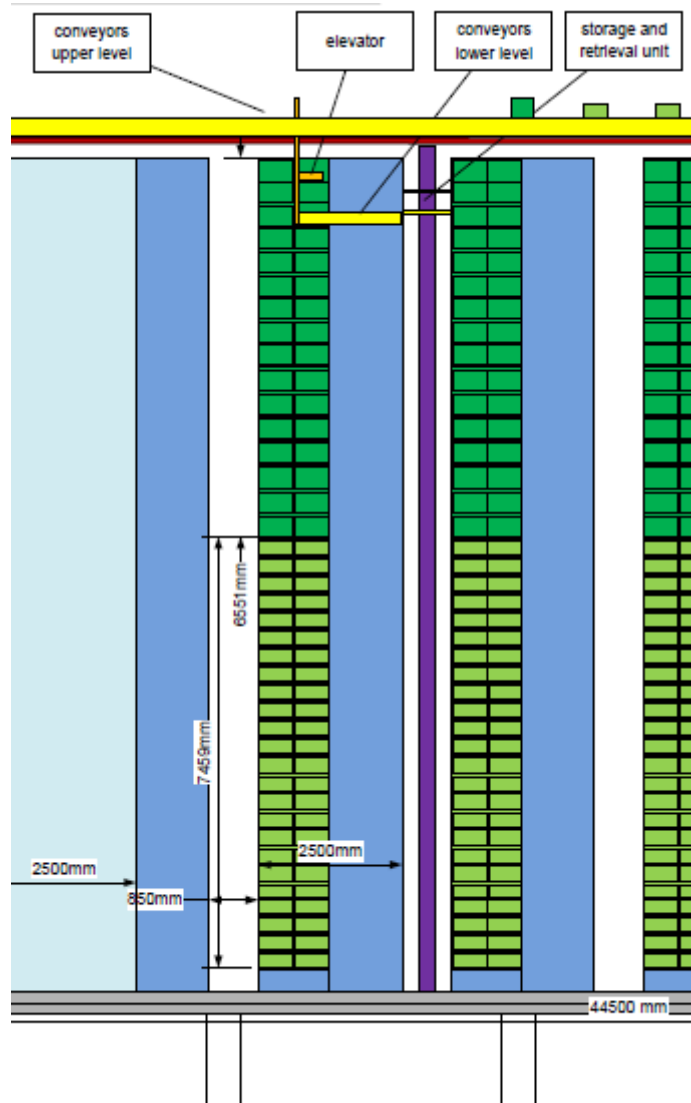
9 alleys for a total of 190'000 bin places.

24 levels (height 250 mm) and 16 levels (height 350 mm) are defined per alley (y-axis).

133 positions for bins in x-axis.

The load handling devices have to manage double-deep storage; they are therefore conceived as a piggyback construction (two load handling devices stacked vertically, each for one bin).

The top guide rail for the cranes are tied to the shelving (not to the building).

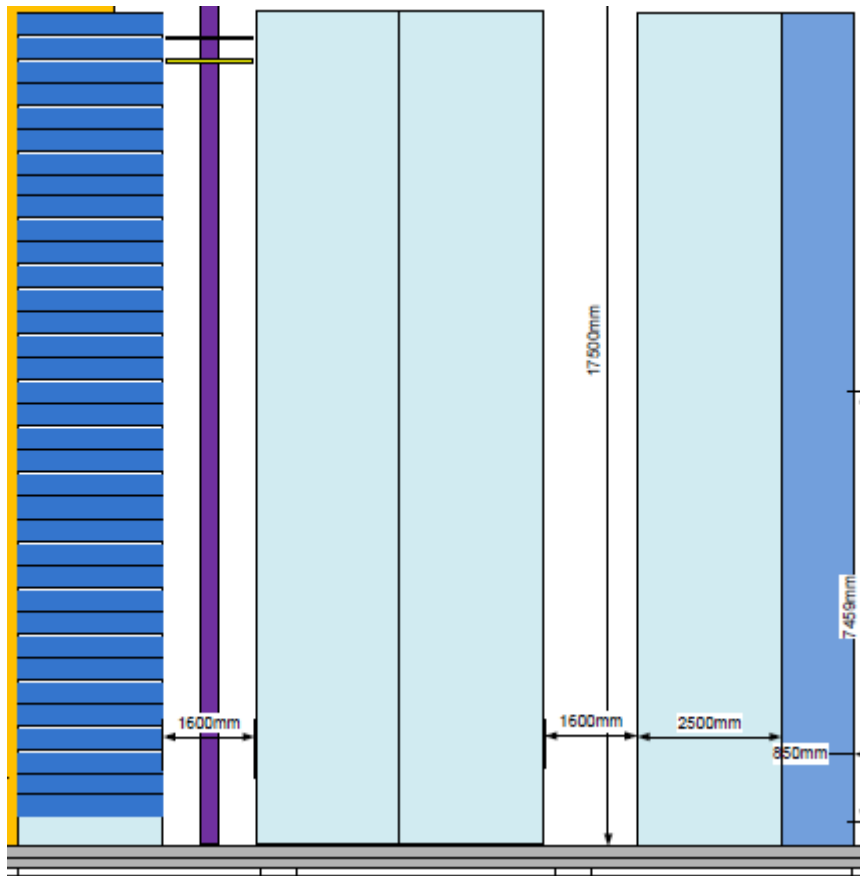


5.1.1.4 Storage and retrieval units for pallet boxes

2 alleys for a total of approximately 24'000 pallet box places (Type 3).
45 levels (height 300 mm) are defined per alley (y-axis).
68 positions for boxes in x-axis.

The load handling devices have to manage double-deep storage; they are therefore conceived as a piggyback construction (two load handling devices stacked vertically, each for one pallet box).

The top guide rail for the cranes are tied to the shelving (not to the building).



5.1.2 Conveyors

5.1.2.1 Conveyor infrastructure for bins

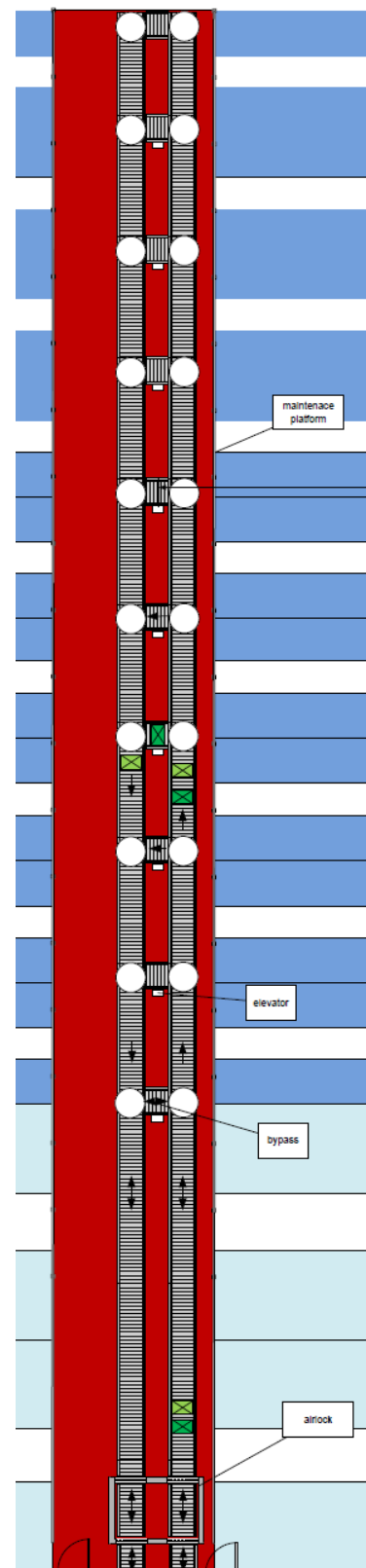
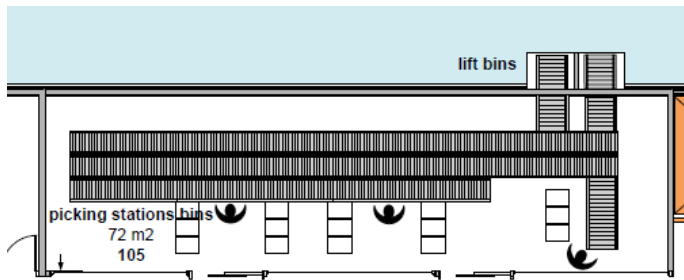
The conveyor infrastructure for the bins is placed in the centre of the storage area, below the roof.

The conveyor elements are either suspended on the roof construction (top level of the framework, ca. 250 kg per metre of conveyor infrastructure), or are propped onto the shelving (ca. 100 kg per metre of conveyor infrastructure).

The cranes run below the conveyor infrastructure; this allows to have only 1 crane per alley. The stations where the bins are passed to the conveyor infrastructure have an elevator; they are propped on the top level of the shelving.

The conveyor infrastructure is defined as a container circulation with zero-pressure sectors and a bypass.

Picking stations are installed on the 1st and 2nd floor of the administration and logistics services area. A future installation of a picking station on the 3rd floor is prepared. The bins are presorted before arriving at the picking stations in a small container circulation.



5.1.2.2 Conveyor infrastructure for pallet boxes

The conveyor infrastructure for the pallet boxes is placed in the front of the storage area, on the level 1st floor.

The conveyor elements are supported by a steel structure on the floor of the warehouse or on onto the shelving.

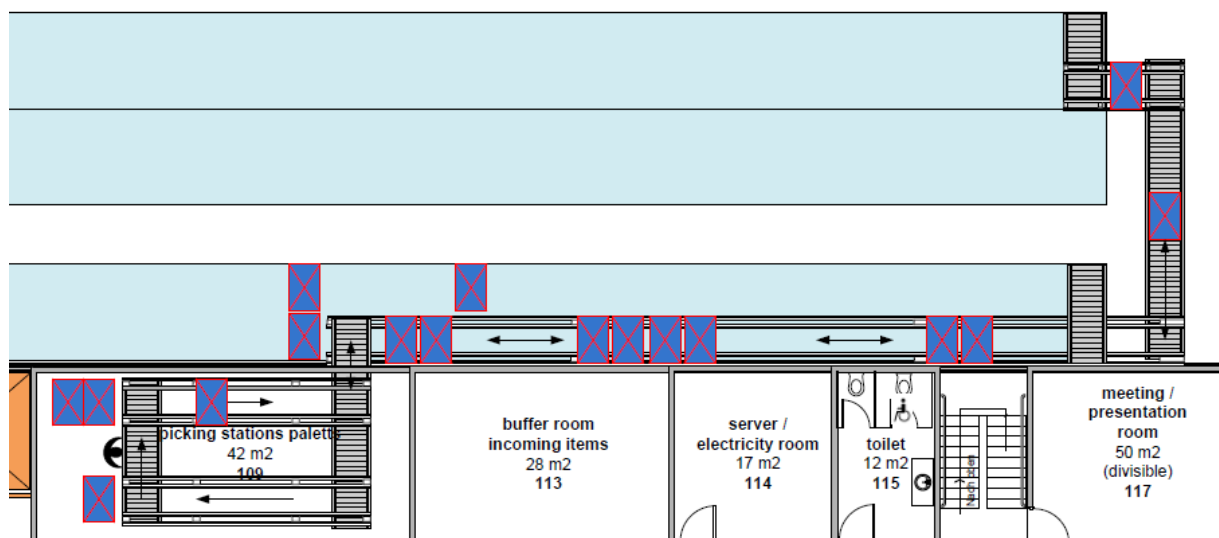
Picking stations are installed on the 1st floor of the administration and logistics services area.

The connection between storage area and picking stations is defined as a one-way line. So blocks of boxes can be stored or swapped out, but not at the same time.

A simultaneous loading and unloading would double the conveying elements. This is very expensive and not recommended for the necessary performance.

A maintenance platform may be required for maintenance and troubleshooting. The regulations are different and have to be clarified with the local security authorities.

If a maintenance platform is required for the pallet transport system, the storage bins can be locked in the WMS. The number of storage bins is reduced by 75 for the conveyors (included in the calculation) and 100 for the possible maintenance platform.



5.2 Performance

5.2.1 Basic data

The following calculations are based on:

- Movement data provided by the KB, (figures for 2017)
- Power input for the various stacking and conveying systems, taken from formerly realized systems
- System performance analogies taken from examples of realized systems, especially from that of the Cooperative Storage Library Switzerland in Büron.

transaction data	category		2017	
				number per Year
	loan to library reading room	recurring		100.000
	loan for mass digitisation	recurring		10.000
	return transfers from end customers	recurring		110.000
	document delivery on paper	recurring		3.200
	document delivery on PDF exchange	recurring		8.500
	conservation and restauration	recurring		175
	exhibition loans	recurring		500

The number of bins and pallets needed were also provided by the KB.

						Growth in one year		
width x length x height (in mm)				items in one container	total of containers	items	items in one container	total of containers
Type 1 Container 366 x 566 x 250 (inside) 400 x 600 x 266 (outside)	height books	position books	items					
Books	till 24.0 cm	standing	2.450.284	29	84.493	20.015	29	690
Periodicals	till 24.0 cm	standing	118.010	29	4.069	500	29	17
Books	34 to 46 cm	laying	23.304	29	804	600	29	21
Periodicals	34 to 46 cm	laying	24.595	29	848	1.000	29	34
Newspapers tabloids	34 to 46 cm	laying	23.625	4,5	5.250	1.350	4,5	300
			-	total	95.464			1.063
Type 2 Container 366 x 566 x 355 (inside) 400 x 600 x 371 (outside)			-					
Books	24 till 34 cm	standing	1.199.169	29	41.351	27.941	29	963
Periodicals	24 till 34 cm	standing	501.375	29	17.289	3.500	29	121
			-		58.639			1.084
Type 3 Large size container 748 x 1040 x 283 (inside) 800 x 1150 x 300 (outside)			-					
Books	47 to 66 cm	laying	7.350	6	1.225	75	6	13
Books	67 to 89 cm	laying	2.100	3	700	75	3	25
Newspapers broadsheet boxed		laying	17.588	4	4.397	-	-	-
Newspapers broadsheet		laying	70.875	6	11.813	150	6	25
			-		18.134			63
Manual storage in m3				m	m3			
Books	90+ cm	laying	1.103	25	25	28	0,84	2
Roles	200 x 10 x 10 cm	laying	352	2 x 2 x 2	8	-	-	-
Other material					149	-	-	-
					182			2
		Growth in one year	15 years					
Type 1 Container 366 x 566 x 250 (inside) 400 x 600 x 266 (outside)	95.464	1.063	111.402					
Type 2 Container 366 x 566 x 355 (inside) 400 x 600 x 371 (outside)	58.639	1.084	74.902					
Type 3 Large size container 748 x 1040 x 283 (inside) 800 x 1150 x 300 (outside)	18.134	63	19.072					
Manual storage in m3	182	2	212					

Only the figures above were used for calculating the necessary performance (no growth over 15 years included!).

5.2.2 Calculations concerning performance

Normal operations, first ingestion empty bins, and first ingestion books and serials are differentiated. The element that limits performance is the elevator for bins.

5.2.2.1 Normal operations

normal operation /h	
movement per stacker	
output	6
input	6
mixed	8,3

5.2.2.2 First ingestion empty bins

	initial storage empty container number / h	number per day	number of days
Anzahl Boxen	720	5760,0	26,7
Anzahl Paletten	100	800,0	22,5

The first ingestion for bins and for pallets can be done in parallel operations (2 separate systems).

5.2.2.3 First ingestion books and serials

	initial storage books /h			
	number of container	number of days	number of containers per day	movements per stacker /h
number container	154000	558,3	275,9	5,7
number palett	18000	72	250,0	23,4
total	172000	630,3	525,9	

It is possible to conduct the first ingestion processes for bins and for pallets in parallel operations at the same time, if there is enough staff.

5.2.2.4 Movements and times

movements / times		movements / h per unit				movements total / h (sec)		
	number of units	initial storage empty containers	initial storage books	normal operation	time per movement (sec)	initial storage empty containers (sec)	initial storage books (sec)	normal operation (sec)
stacker cranes container	9	30	9	8,3	120	32400	9310	8962
stacker cranes palett	2	13	23	8,3	150	3750	7031	2489
conveyor container	200	270	78	74,7	15	810000	232759	224039
conveyor palett	30	25	47	16,6	12	9000	16875	5974
elevator container	2	270	78	74,7	15	8100	2328	2240
elevator palett	5	25	47	17	8	1000	1875	664

Please note that the phase of first ingestion overlaps more and more with normal everyday operations! The available system performance is quite sufficient to cope with this overlap.

The first ingestion of books and serials needs some 560 days, with an ingestion performance of ca. 8'000 items per day. That corresponds to roughly 2'000 items per picking station.

An increase could be achieved by using the NIO stations (Not in Order, i.e. too high, too heavy) with mobile workplaces, and/or with an increase in working hours.

It would be possible to further raise ingestion performance and thus shorten the time for the first ingestion phase. But this would require high additional investments (elevator for bins, picking stations); it is therefore not recommended.

5.3 Energy

5.3.1 Energy/h for logistic systems

The following table shows energy consumption as well as active and reactive power for the 3 different phases.

energy	number of units	power consumption	efficiency	coincidence factor	energy / h kWh					
					initial storage empty container		initial storage books		normal operation	
					active power	reactive power (heat)	active power	reactive power (heat)	active power	reactive power (heat)
stacker cranes container	9	24	90	0,7	136	15,1	39	4	38	4
stacker cranes palett	2	45	90	0,7	30	3,3	55	6	20	2
conveyor container	200	0,3	88	0,6	36	4,9	10	1	10	1
conveyor palett	30	0,55	88	0,6	1	0,1	1	0,2	0,5	0,1
elevator container	2	9	85	0,7	12	2	3	0,6	3	0,6
elevator palett	5	2	85	0,8	0	0,1	1	0,1	0,3	0,04
total energy					214	26	110	13	71	8

Please note that, here too, the phase of first ingestion overlaps more and more with normal everyday operations!

5.3.2 Reactive power per hour/ per day, per m3

	m3	kWh/m3	kWh/m3	kWh/m3
reactive power heat per m3	cubature storage	54000	0,00047	0,00024
reactive power heat per m3 and day			0,00379	0,00190
				0,00124

A full operative day was calculated with 8 h.

operating time / duration	number of days	number of hours	number of days	number of hours
	27	8	558,3	8

The sporadic ventilation movements during the night are negligible from a point of view of energy consumption.

These calculations and data are the basis for the calculations and results of HALMOS.

Annex 6: Performance and energy

Annex 7: Results HALMOS

6 Contact Persons

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7 Annexes

- Annex 1: Layout plan of the plot and concept for the situation of the building and for accessibility*
- Annex 2: Layout storage area*
- Annex 3: Layout administration and logistics part of the building*
- Annex 4: Functional Spaces KB*
- Annex 5: Floor and walls requirements*
- Annex 6: Performance and energy*
- Annex 7: Results HALMOS*
- Annex 8: drawing bins Type 1*
- Annex 9: drawing bins Type 2*

8 Confirmation

We confirm the receipt and content of this documentation

Den Haag,

signature.....

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