FUTURISTIC CONTAINER TERMINAL STORAGE & DISTRIBUTION SYSTEM BY REVERSE STACKING OF CONTAINER

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PRESENT METHOD OF CONTAINER STACKING

- Shipping containers are stacked normally one on top of the other from the ground by a lifting machine, eg. crane. So the height of stacking is limited by height to which the lifting machine can stack. The present stacking height in the industry is generally up to 6-7 container tier high.

PRESENT STACKING OF CONTAINERS

CELL GUIDE IN SHIP

- Present day shipping container storage and handling system requires :
  1. Extensive and expensive land area in premium waterfront;
  2. Complicated handling facility with multitude of equipment;
  3. Extensive man-power of various skills to support this complicated system.

Based on the ISO standard ISO 668 & ISO 1496-1 : 1990 and today's in transport technology a fundamental approach has been taken to propose a State-Of-Art storage, handling and distribution system.

REVERSE STACKING OF CONTAINER

HOW MANY TIERS CAN ISO CONTAINERS BE STACKED VERTICALLY

APPENDIX 1

FORCES TO BE APPLIED IN STACKING TEST

Table 3 — Forces to be applied in stacking test

Container designation	Test force per container (all four corners simultaneously)		Test force per pair of end fittings		Superimposed mass represented by test force	
	kN	lbf	kN	lbf	kg	lb
1A, 1AA and 1AX	3 392	762 550	1 696	381 275	192 000	423 290
1B, 1BB and 1BX	3 392	762 550	1 696	381 275	192 000	423 290
1C, 1CC and 1CX	3 392	762 550	1 696	381 275	192 000	423 290
1D and 1DX	896	201 600	448	100 800	50 800	112 000

NOTE — The test force of 3 392 kN per container is derived from the superimposed mass of nine-high stacking, i.e. eight containers stacked on top of one container, all being rated to 24 000 kg, and an acceleration force of 1,8 *g*. [The corner posts of such containers are known to have been tested to 86 400 kg (190 480 lb).]

ISO 1496-1 : 1990 (E)

SO AN ISO CONTAINER CAN SAFELY WITHSTAND A VERTICAL TEST LOAD OF 192T WITH A FACTOR OF SAFETY OF 1.8

APPENDIX 2

ESTIMATION OF STACKING HEIGHT

FROM THE TEST LOADS AS PER APPENDIX 1 GENERAL PURPOSE CONTAINER WILL BE SUBJECTED TO VERTICAL FORCE 192T WITH A FACTOR OF SAFETY OF 1.8

NO		THEORATICAL STACKING HEIGHT OF CONTAINER = 192 TONNES OF TOTAL WEIGHT OF CONTAINER			
		20’		40’	
		WT (t)	HT (Tires) = 192T / (3)	WT (t)	HT (Tires) = 192 / (5)
(1)	(2)	(3)	(4)	(5)	(6)
1	EMPTY	2.3	83	3.75	38
2	MAX. GROSS	32.5	6	32.5	6
3	AVERAGE WEIGHT OF 8T/CONTAINER	8	24	8	24
4	AVERAGE WEIGHT OF 14T/CONTAINER	14	13	14	13

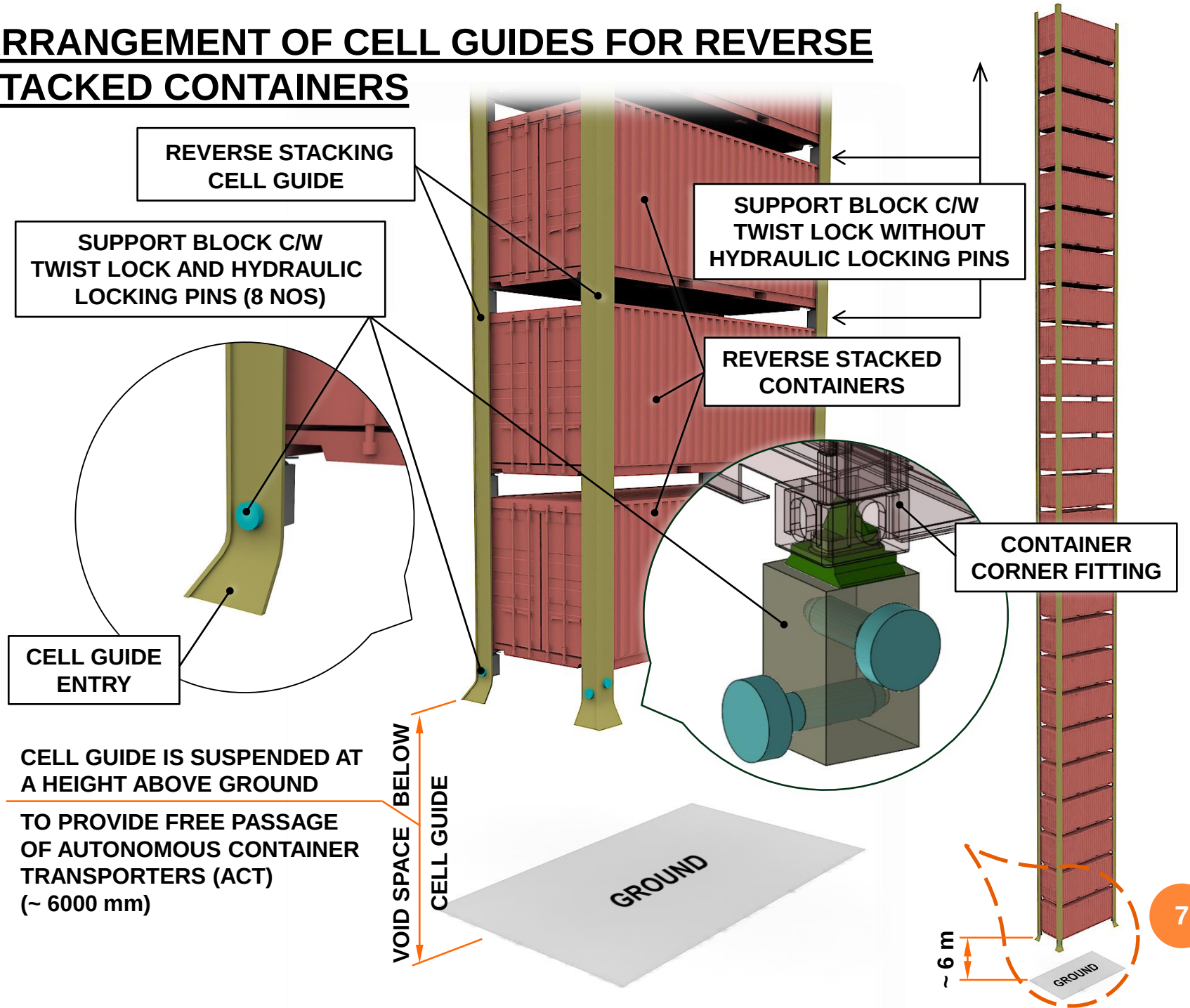
1. CAN BE CONSIDERED FOR STORAGE FOR EMPTY CONTAINERS.

2. ONLY PRACTICAL FOR ISO TANK CONTAINERS.

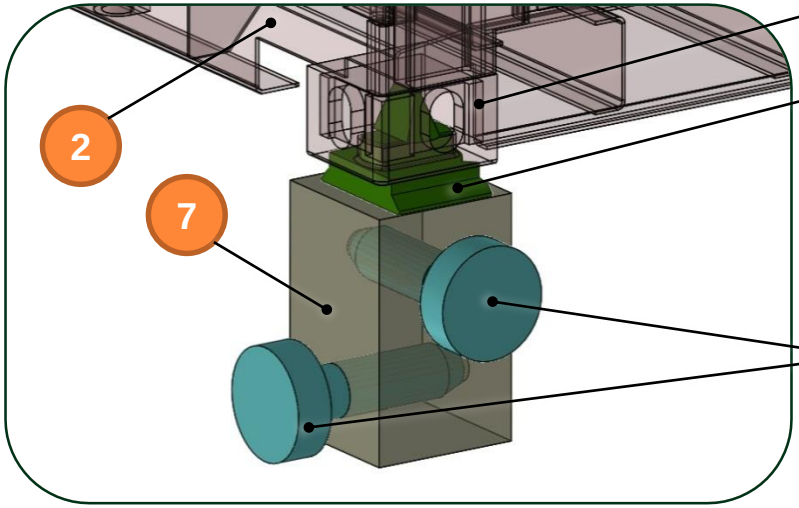
3 & 4. ACTUAL RANGE OF GROSS WEIGHT OF SHIPPED CONTAINERS.

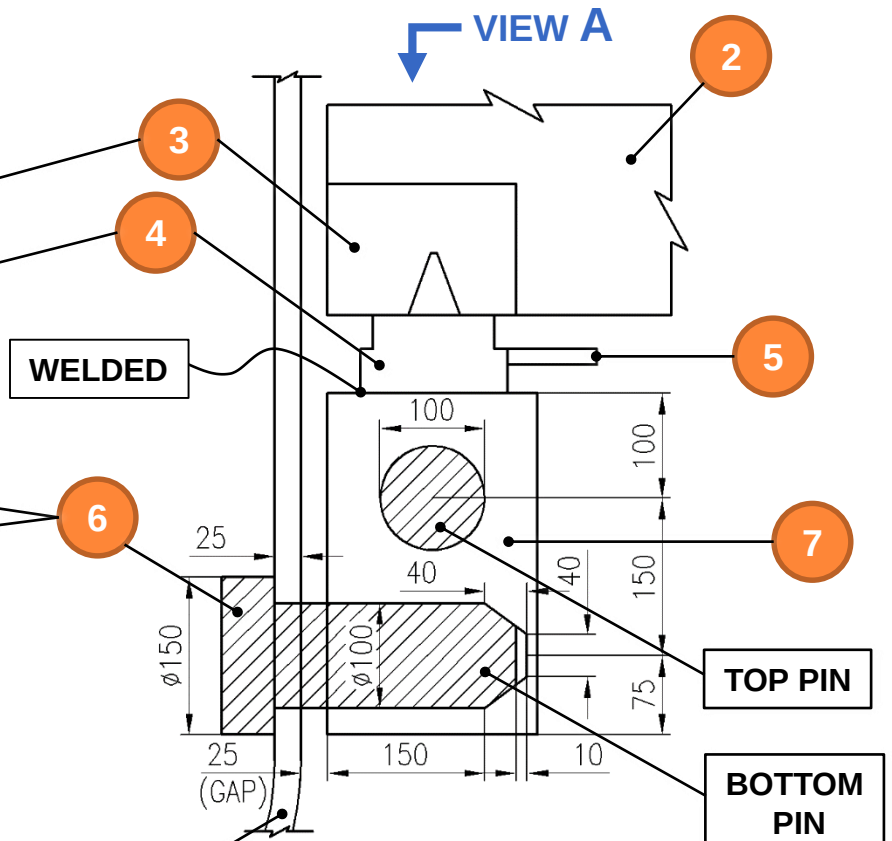
SO BASICALLY ISO CONTAINERS CAN BE STACKED TILL THE TOTAL WEIGHT OF THE STACK REACHES 192T.

ARRANGEMENT OF CELL GUIDES FOR REVERSE STACKED CONTAINERS

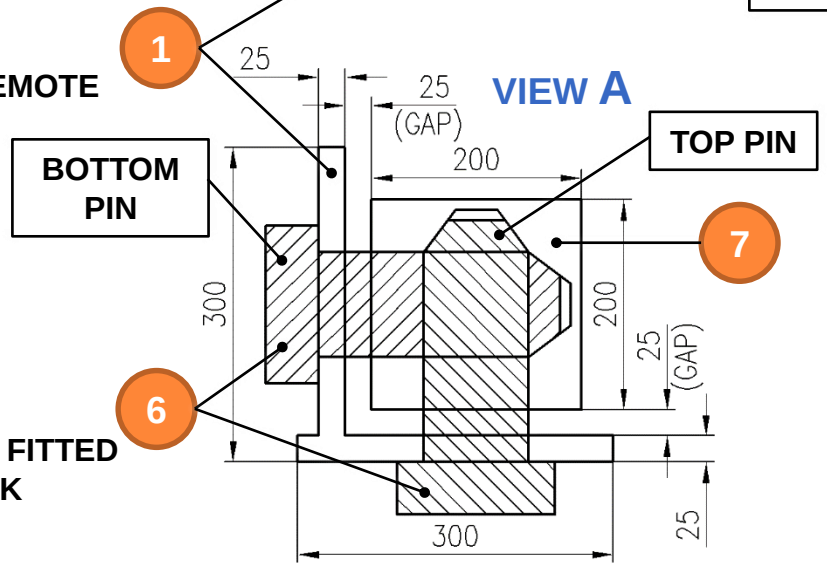


CONTAINER SUPPORT SYSTEM IN REVERSE CELL GUIDE





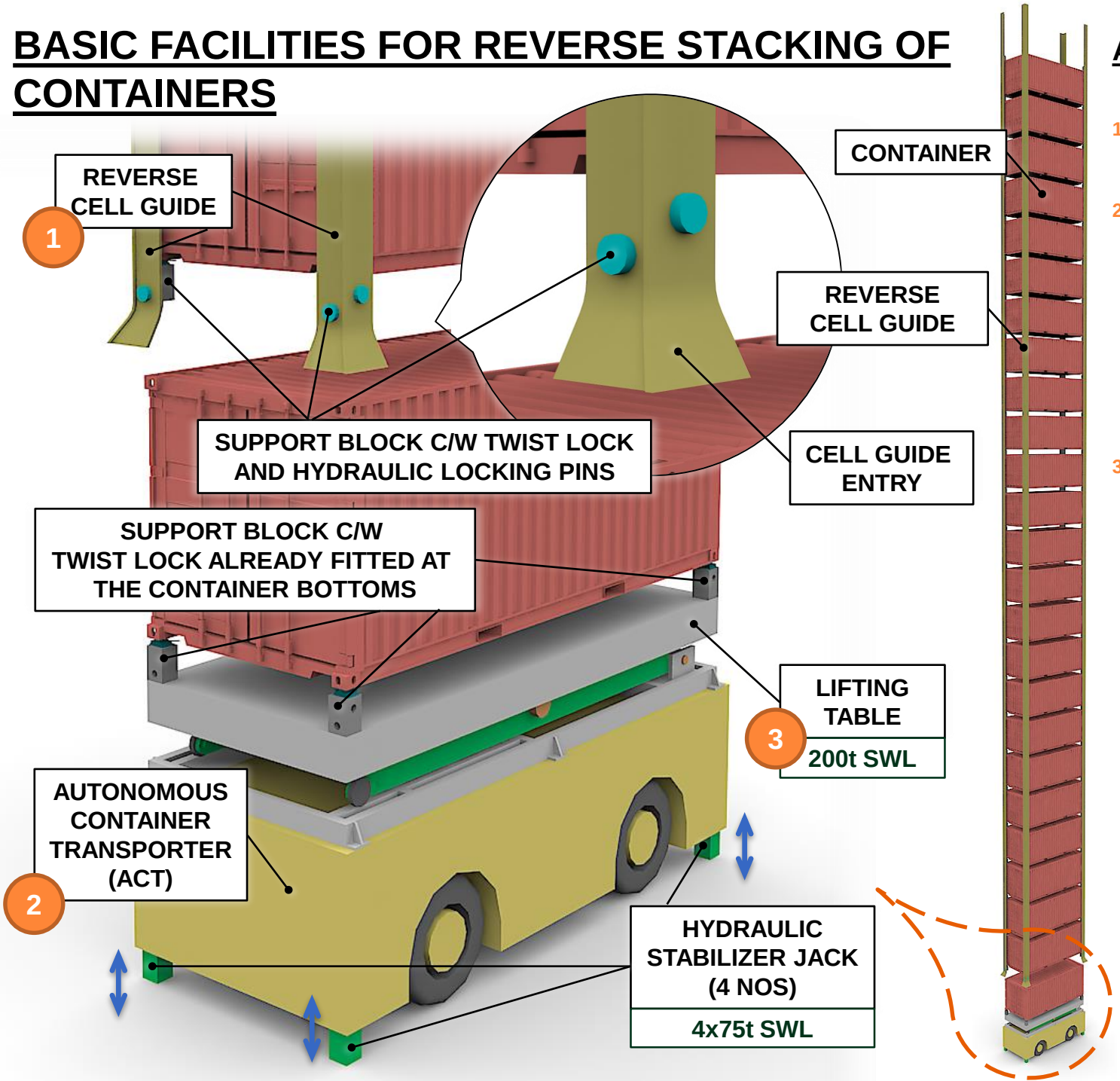
1. REVERSE CELL GUIDE
2. CONTAINER
3. CORNER FITTING
4. WELDABLE DOVETAIL TWIST LOCK
5. TWIST LOCK HANDLE (TO BE FITTED WITH REMOTE ACTUATION)
6. HYDRAULICALLY ACTUATED LOCKING PINS NOS PER CONTAINER)
7. SUPPORT BLOCK (4 NOS PER CELL STACK)



NOTE :

EVERY CONTAINER CORNER FITTING SHALL BE FITTED WITH SUPPORT BLOCK WELDED TO TWIST LOCK

BASIC FACILITIES FOR REVERSE STACKING OF CONTAINERS



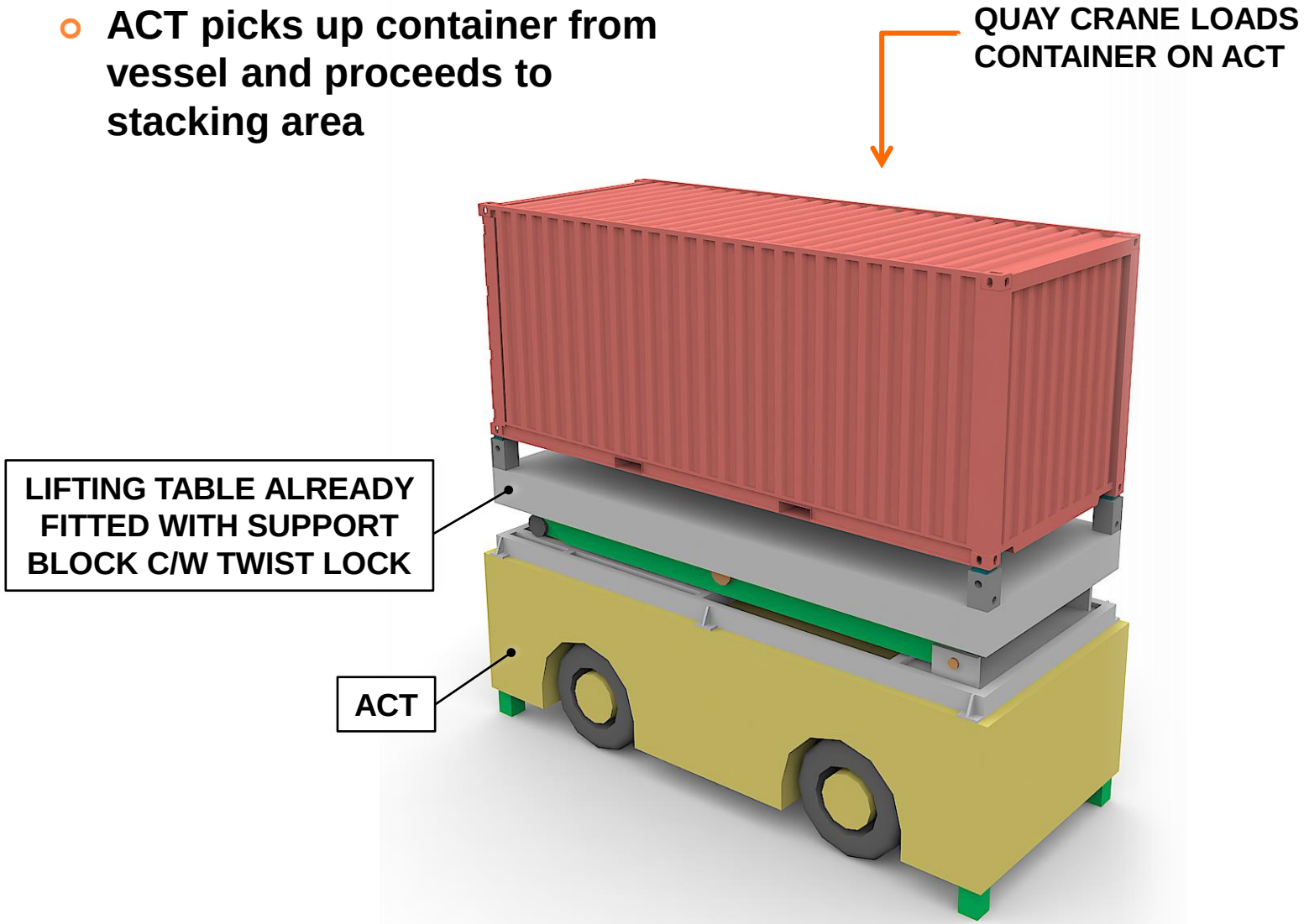
APPENDIX 3

1. REVERSE CELL GUIDE
2. AUTONOMOUS CONTAINER TRANSPORTER (ACT) – It is driver-less electric vehicle to transport container
3. LIFTING TABLE (200T SWL) TO REVERSE STACK CONTAINERS.

STACKING UP OF CONTAINER

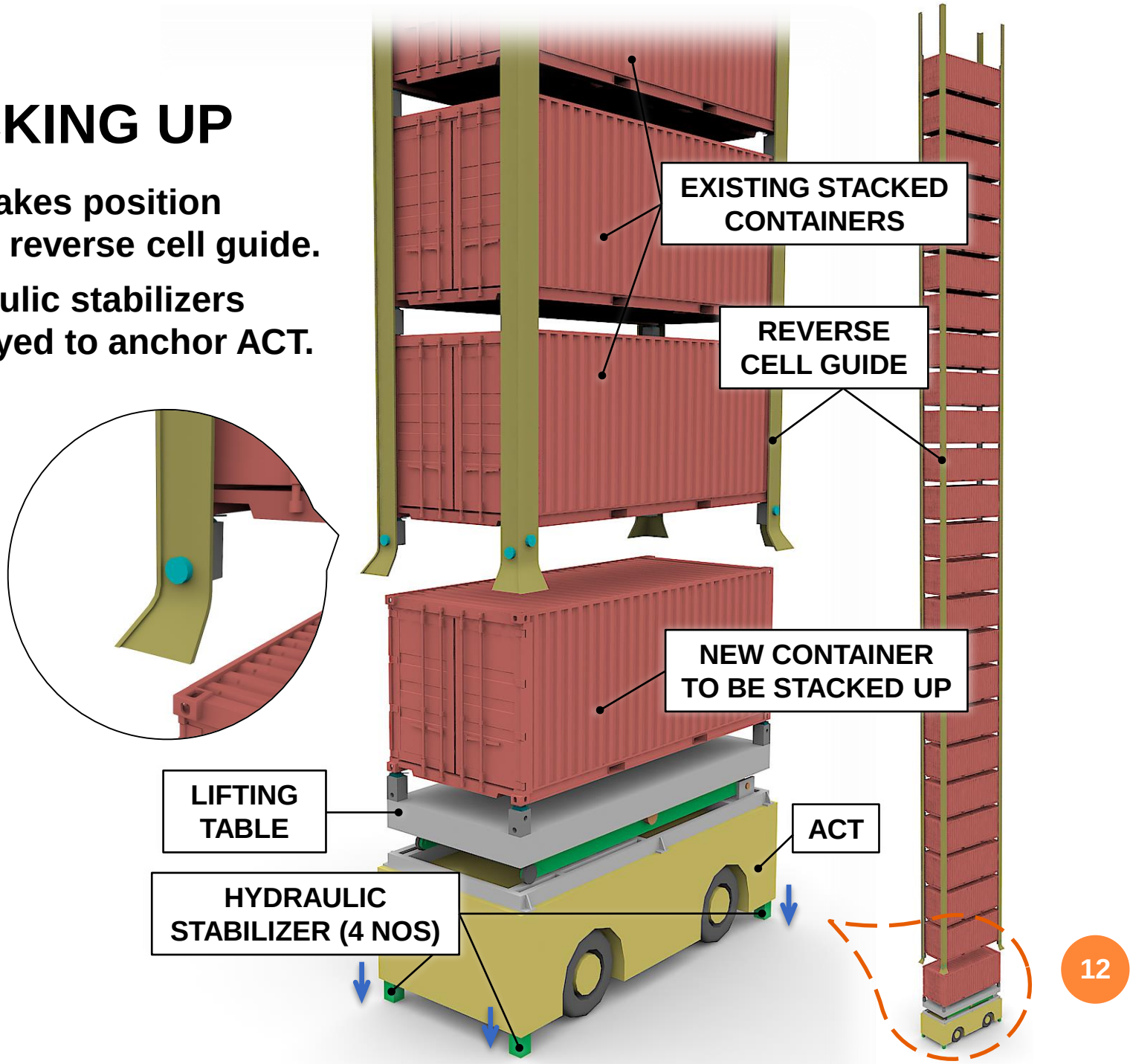
STACKING UP

- ACT picks up container from vessel and proceeds to stacking area



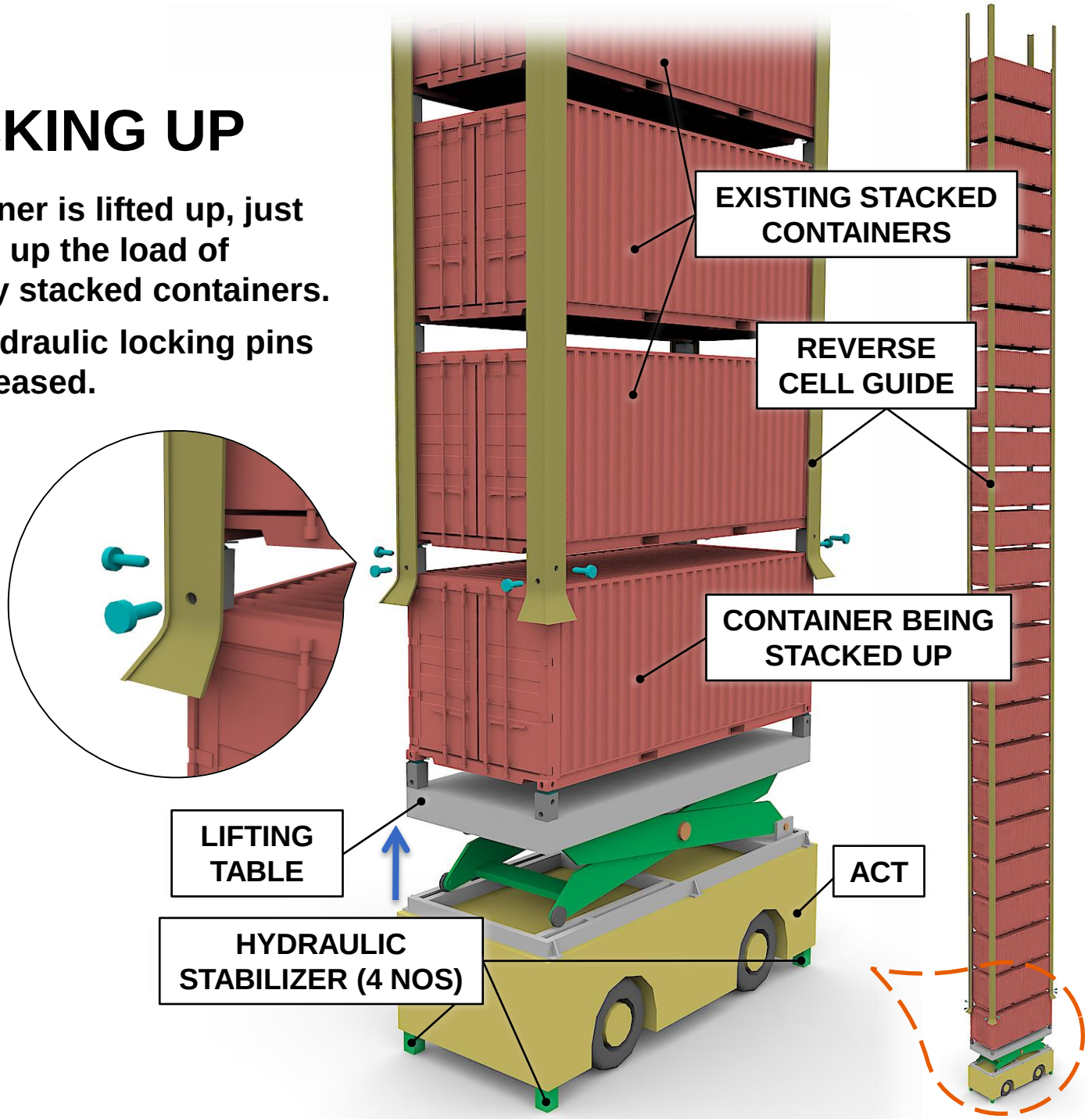
STACKING UP

- ACT takes position below reverse cell guide.
- Hydraulic stabilizers deployed to anchor ACT.



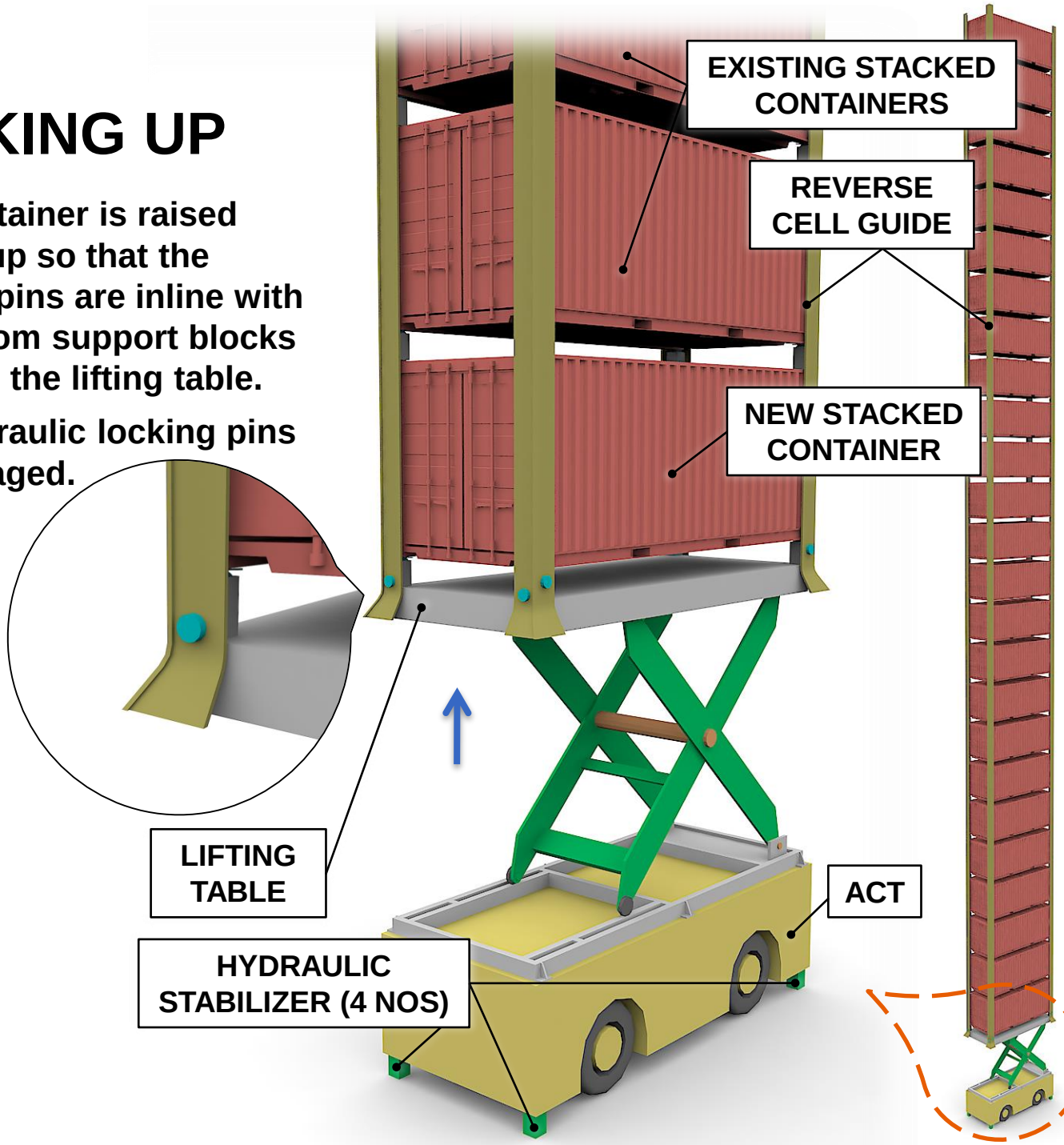
STACKING UP

- Container is lifted up, just to take up the load of already stacked containers.
- The hydraulic locking pins are released.



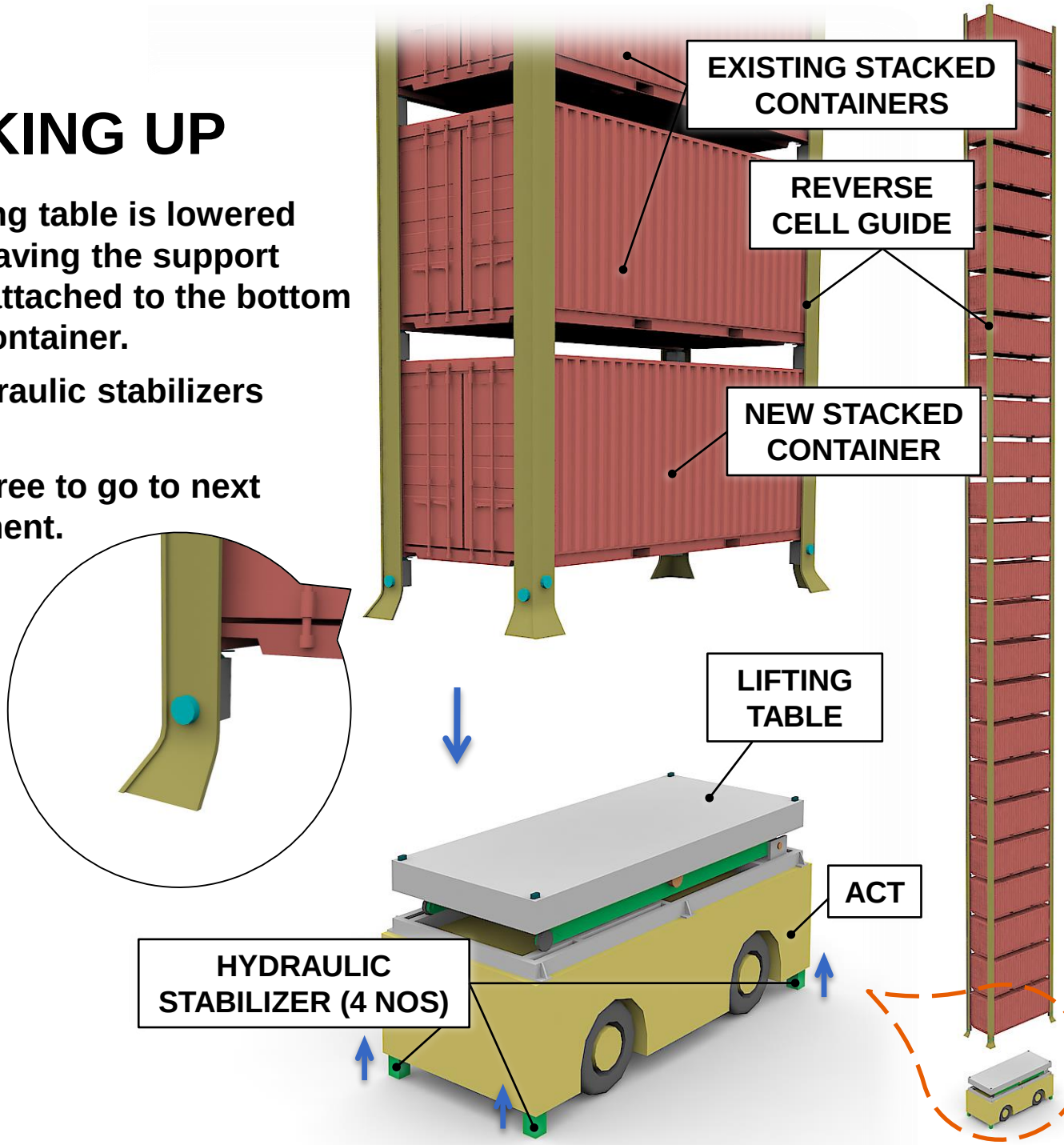
STACKING UP

- The container is raised further up so that the locking pins are inline with the bottom support blocks fitted on the lifting table.
- The hydraulic locking pins are engaged.



STACKING UP

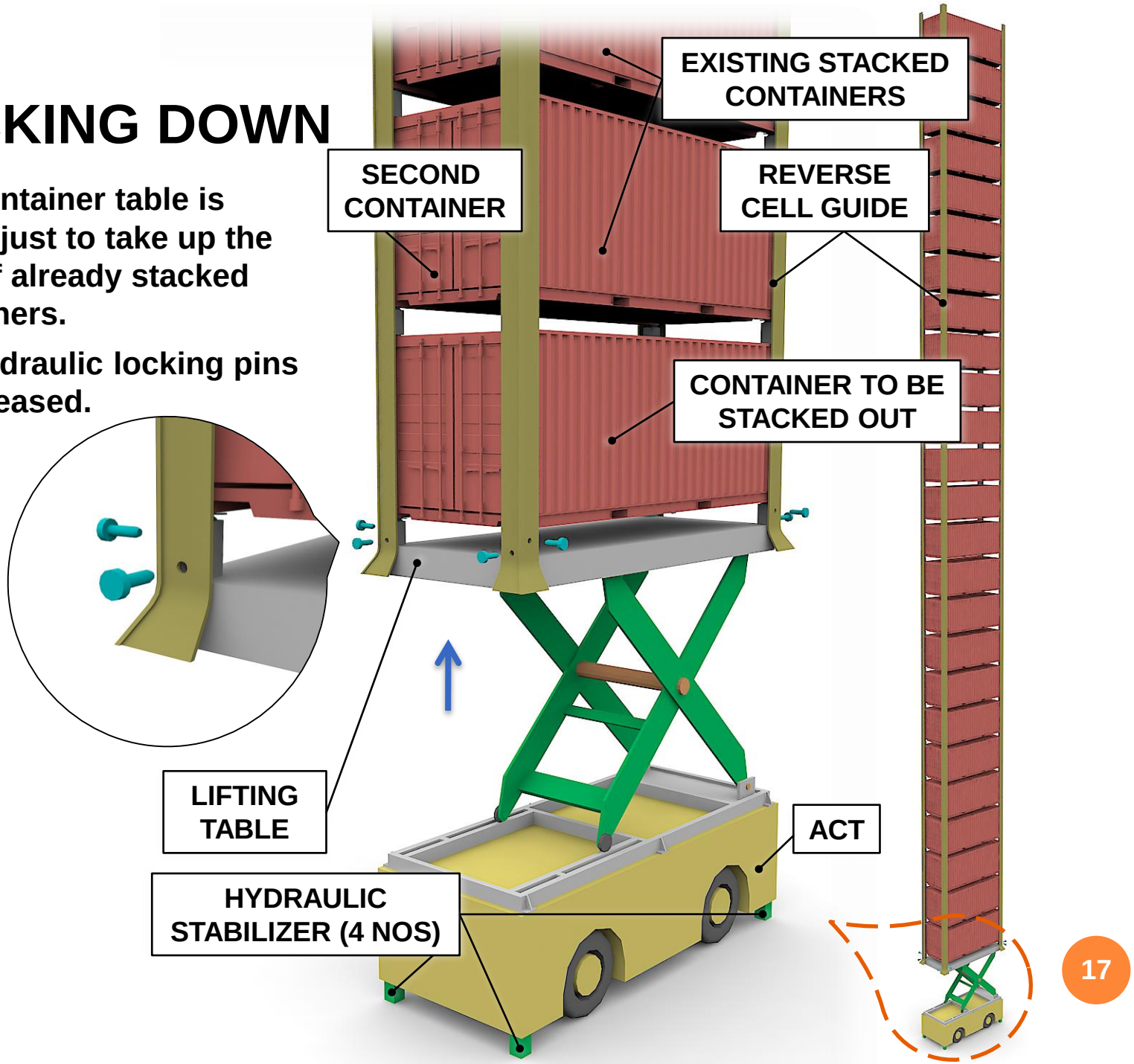
- The lifting table is lowered down leaving the support blocks attached to the bottom of the container.
- The hydraulic stabilizers retract.
- ACT is free to go to next assignment.



STACKING DOWN OF CONTAINER

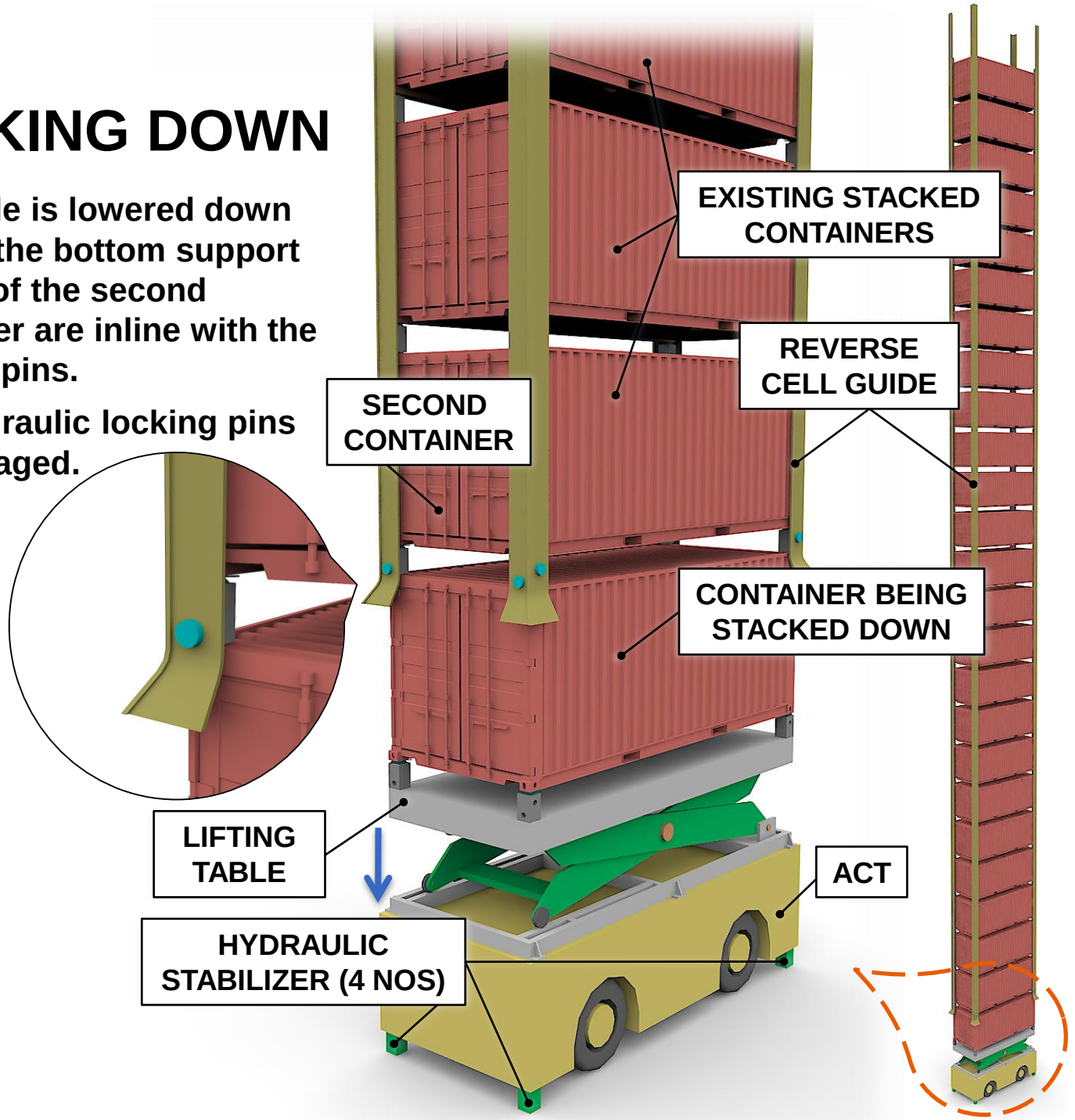
STACKING DOWN

- The container table is raised just to take up the load of already stacked containers.
- The hydraulic locking pins are released.



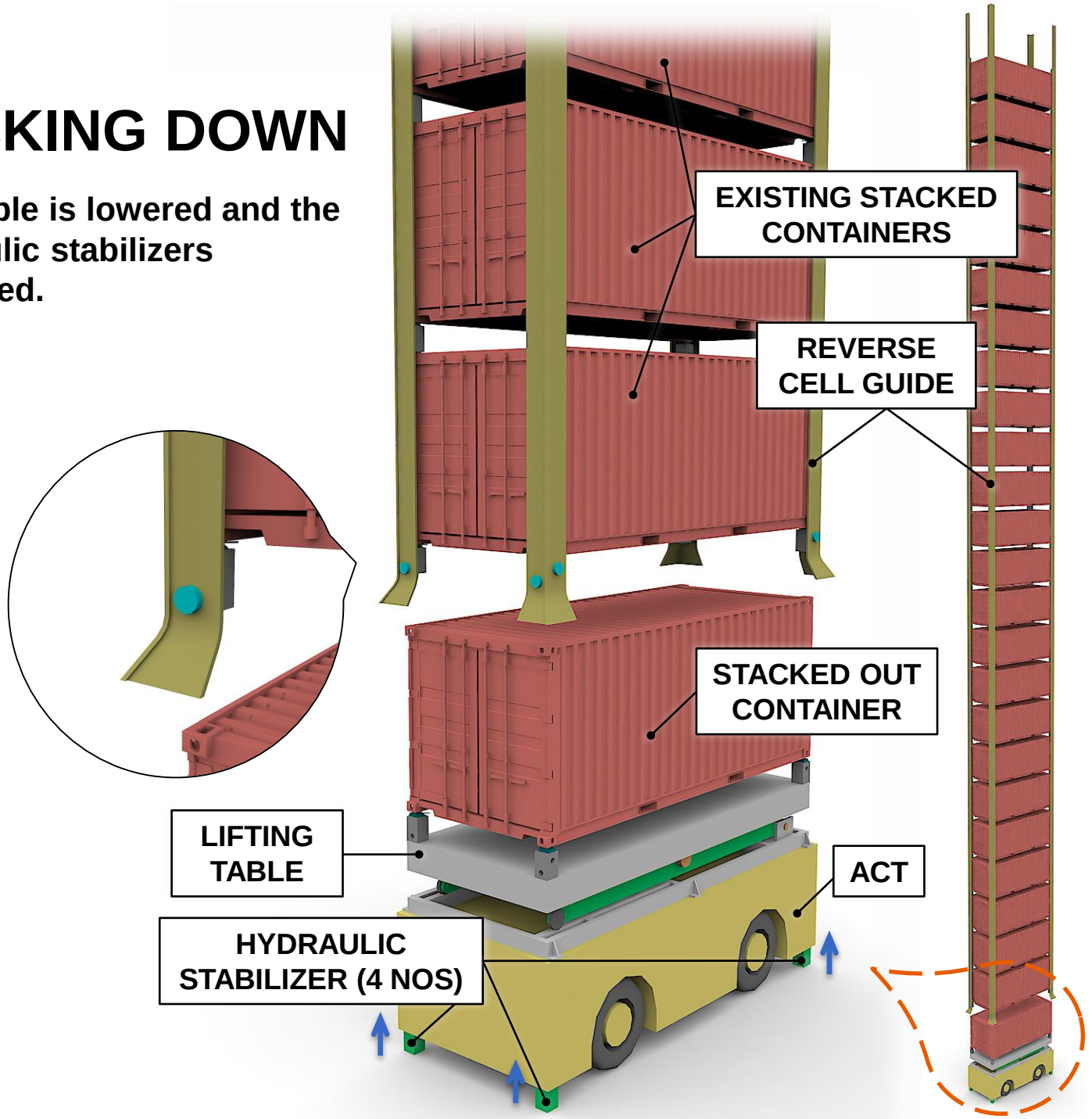
STACKING DOWN

- The table is lowered down so that the bottom support blocks of the second container are inline with the locking pins.
- The hydraulic locking pins are engaged.



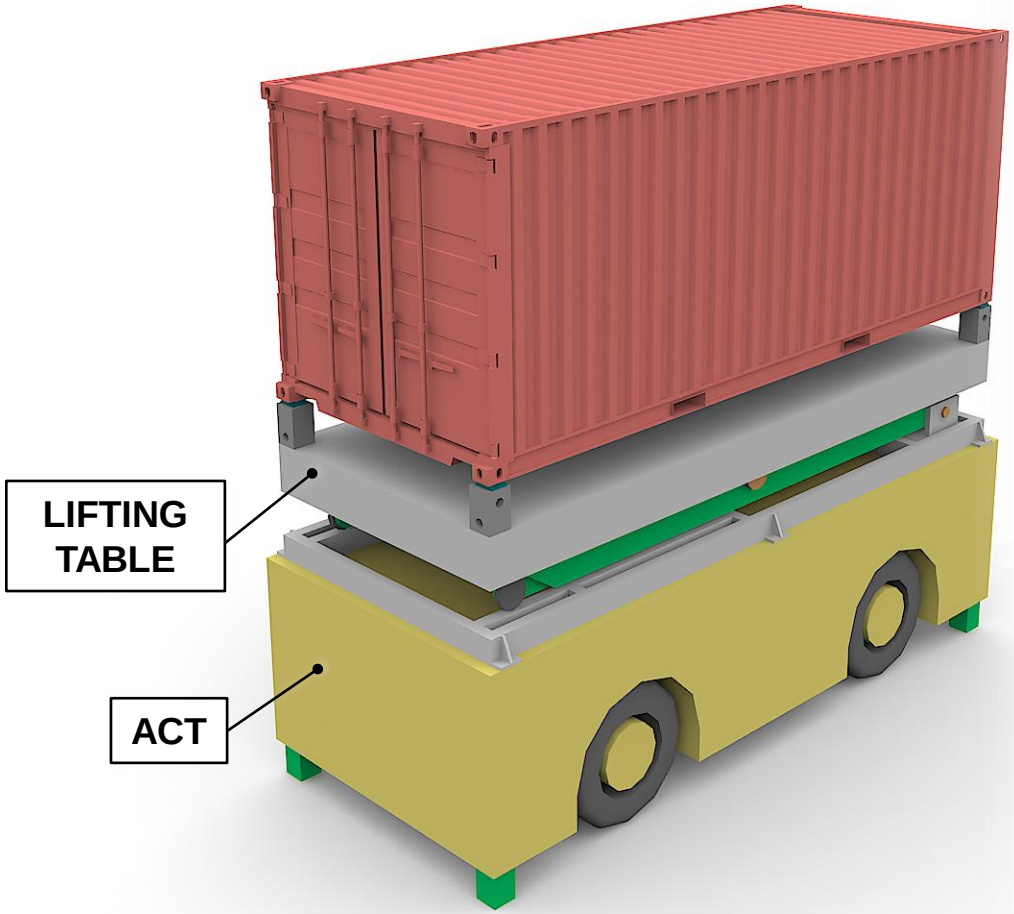
STACKING DOWN

- The table is lowered and the hydraulic stabilizers retracted.

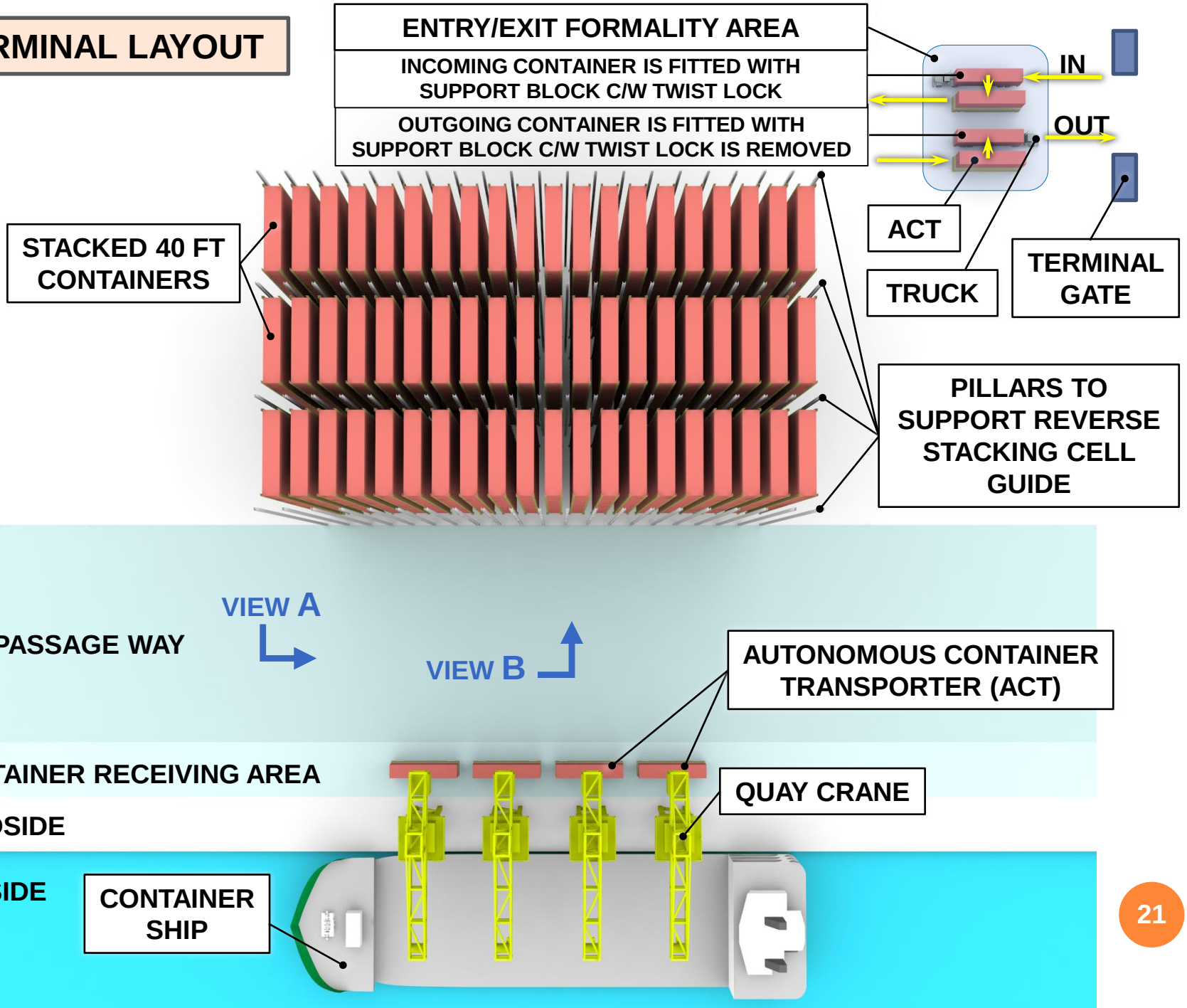


STACKING DOWN

- **ACT is ready to leave to deliver the container to its next intended assignment.**



TERMINAL LAYOUT



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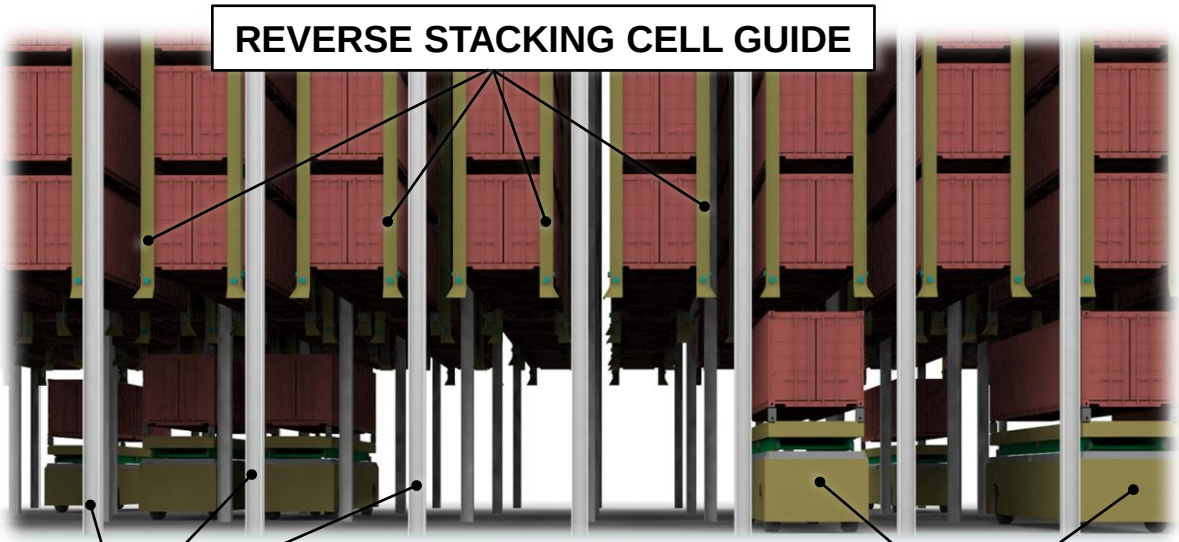
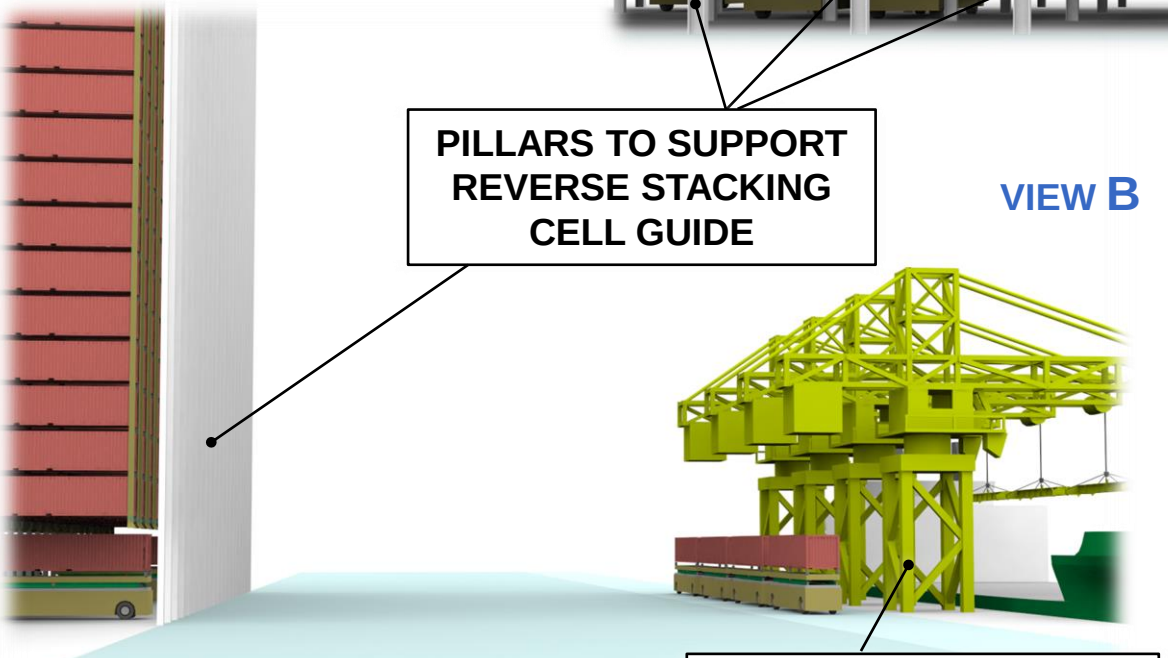


PILLARS TO SUPPORT REVERSE STACKING CELL GUIDE

VIEW B

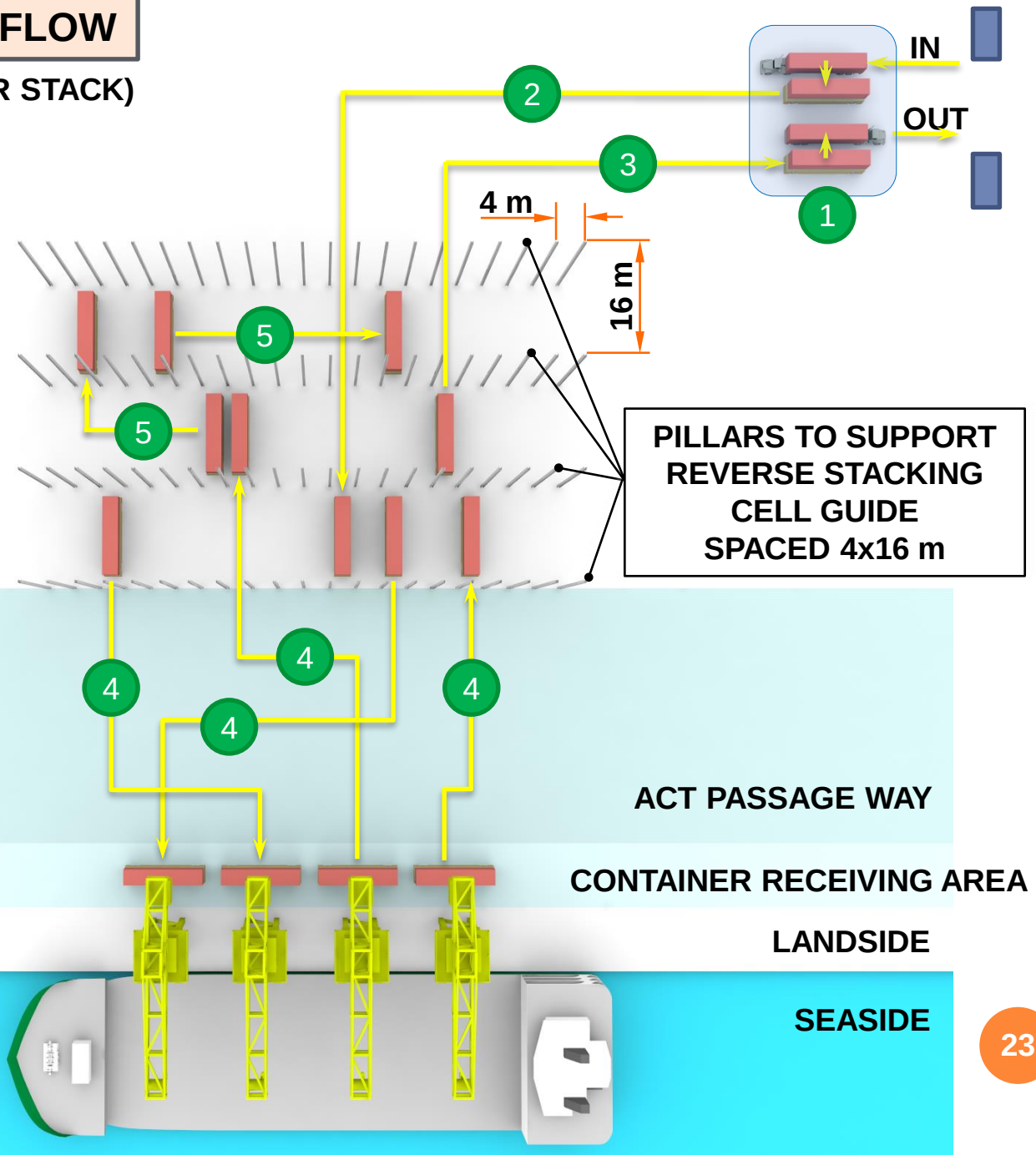
PROVIDES FREE ACCESS THROUGHOUT



TERMINAL TRAFFIC FLOW

(VIEW BELOW CONTAINER STACK)

1. Terminal access formality area
   - Security check
   - Custom
   - Etc.
2. To terminal process area
3. Delivery to receiver
4. ACTs can move through the stack area freely finding its way to the appropriate stack
5. ACTs sorting containers as per shipment requirement



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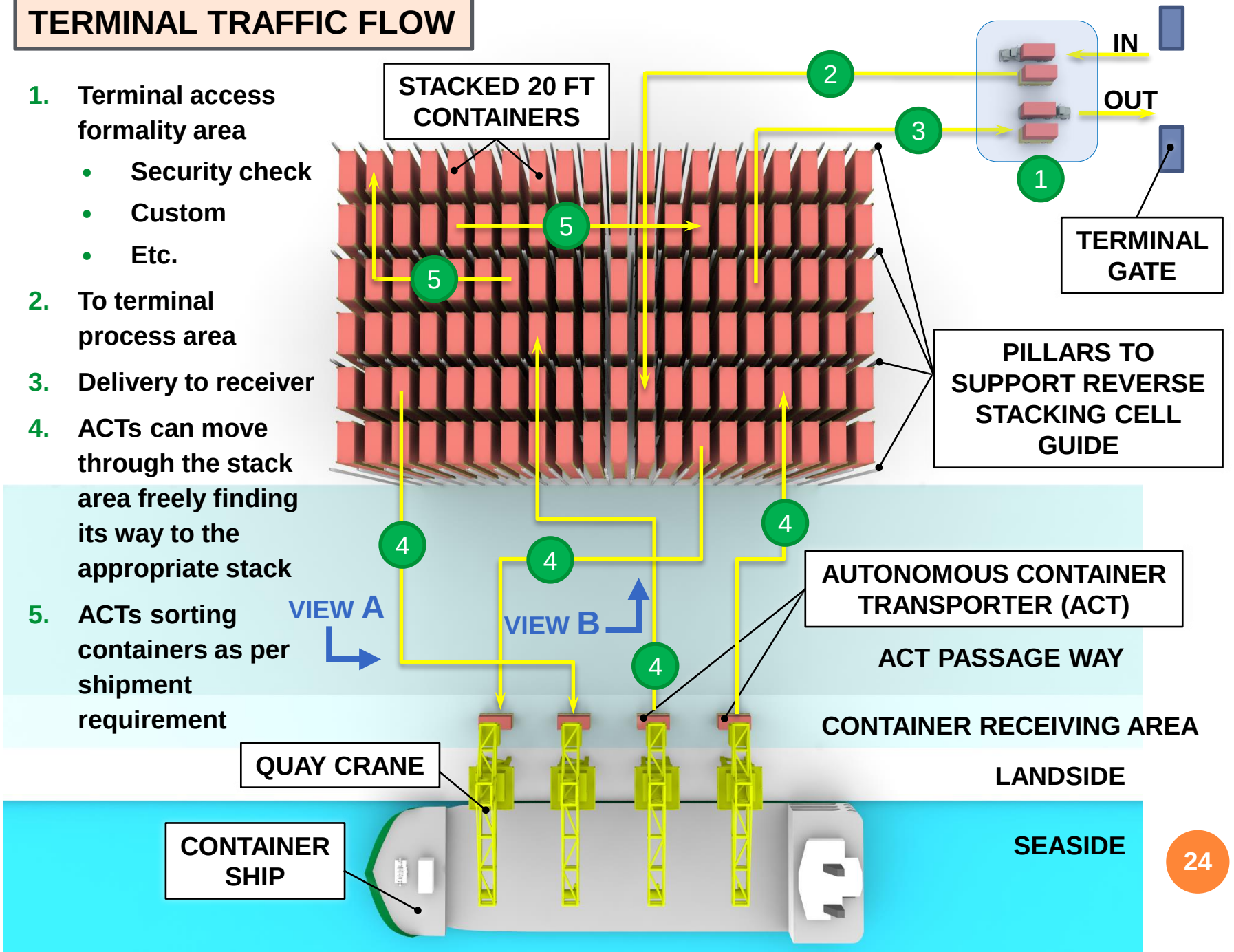


APPENDIX 4

COMPARISON OF EQUIPMENT NEEDED TO OPERATE A CONTAINER TERMINAL

NO	EQUIPMENT	EXISTING TERMINALS	PROPOSED REVERSE STACKED STORAGE TERMINAL
1	QUAY CRANES	YES	YES
2	CHASSIS	YES	NO
3	STRADDLE CARRIER	YES	NO
4	REACH STACKER	YES	NO
5	FORKLIFT	YES	NO
6	FRONT END LOADER	YES	NO
7	GANTRY CRANES	YES	NO
8	AUTOMATED GUIDED VEHICLE (THESE NEED TO BE GUIDED)	YES	NO
9	PROPOSED AUTONOMOUS CONTAINER TRANSPORTER (ACT) FITTED WITH LIFTING TABLE (200T LIFTING CAPACITY) (THESE VEHICLES LIKE DRIVERLESS CARS CAN NAVIGATE AND OPERATE BY THEMSELVES)	-	YES
10	REVERSE CELL GUIDE FOR STACKING	NO	YES

ADVANTAGES OF THE PROPOSED REVERSE STACKED CONTAINER STORAGE SYSTEM OF TERMINAL LAYOUT

1. About 3 to 20 times as many TEUs can be stacked per square area as of storage. (see Appendix 6)
2. Much higher utilization of available premium terminal space.
3. No wastage of space for designated roadways for vehicle transport.
4. The entire terminal area is available for access all the time including the container storage area. ACT can freely move through the void area below stacks.

5. The most critical bottleneck is the Quay Cranes which generally serves at about on an average 30 TEU / hour. All the other facility can be designed to suit this rate of through put.
6. In existing system : Gantry cranes, straddle cranes can serve each bay (stacks) only one at a time.
7. Autonomous Container Transporter (ACT) will perform all activities from receiving containers from Quay Cranes to transporting to the appropriate stacking cell guide point and stack the container and vice versa.
8. ACTs will also do sorting and pre-stacking according to loading schedule independently and simultaneously.
9. No human presence is required in the entire operation except at central control, management centre and maintenance department.

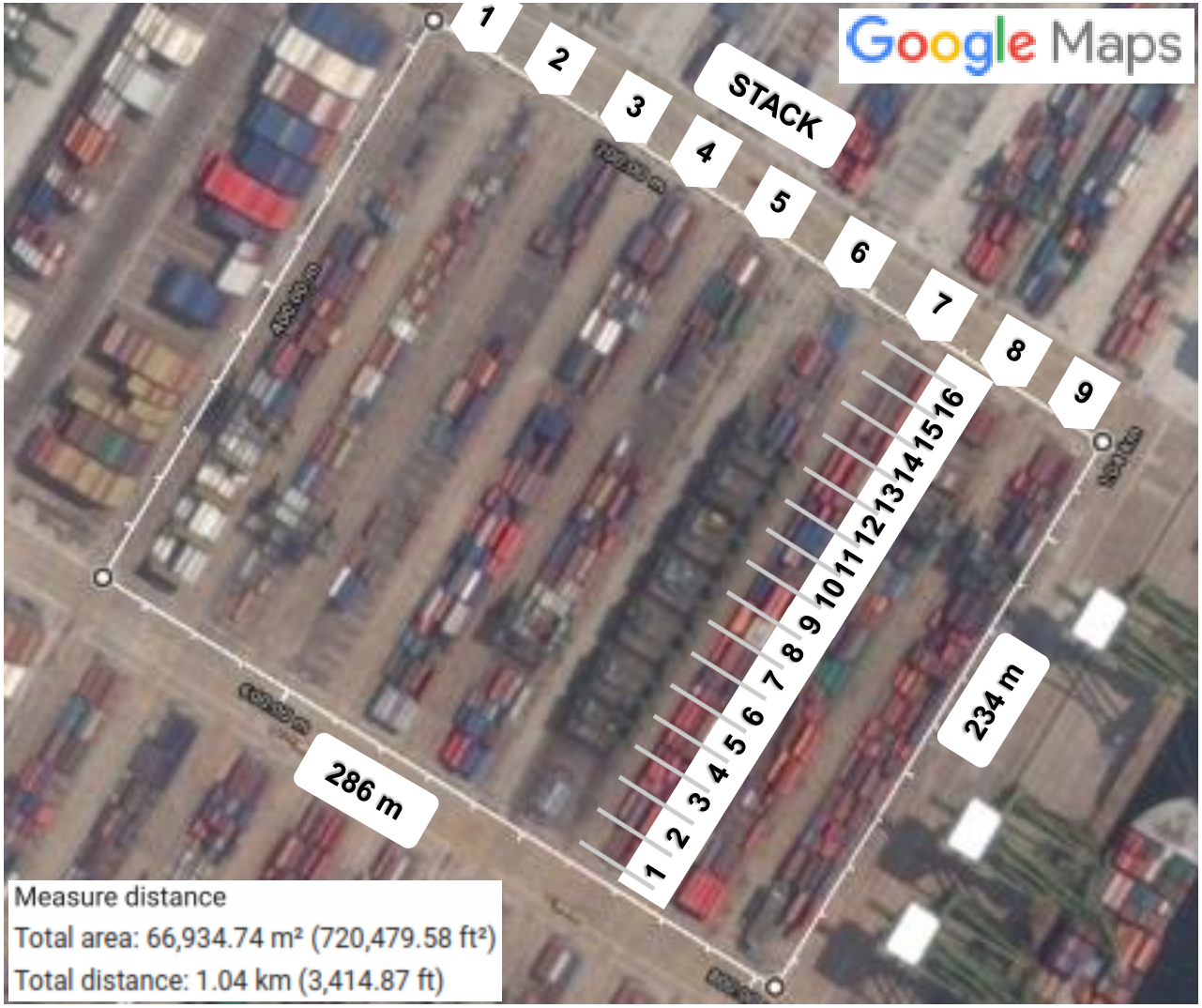
- This requires just three basic facilities :
  1. Existing Quay cranes
  2. Specially designed reverse cell guide, i.e. stacking the containers from the bottom of cell guide (top stacking cell guide is already used in Container ships).
  3. Specially designed battery powered Autonomous Container Transporter (ACT) (based on driverless car technology for its navigation and operation. Rest of the multitude of equipment used in today's system can be practically dispensed with (see Appendix 3 and 4).
  4. Lifting Table (200 T SWL Lifting Capacity) Specially designed and programmed to reverse stack-up and stack-down containers into reverse cell guides. The technology is commercially existing in industry.

ACTUAL TERMINAL STUDY

PART PICTURE OF PSA TERMINAL 3 – SINGAPORE

NUMBER OF STACK ROWS = 9

EACH STACK IS 6X16 40 FT CONTAINERS



CONTAINER STORAGE DENSITY COMPARISON SAMPLE AREA IN PASIR PANJANG TERMINAL 3 – SINGAPORE (REF. GOOGLE PICTURE)

LENGTH = 286.0 M (FROM PICTURE ONE CAN COUNT 9 STACK)

BREADTH = 234.0 M (FROM PICTURE ONE CAN COUNT FOR EACH STACK 16 NOS 40 FT AND 6 ABREAST CONTAINERS HAVE BEEN ARRANGED).

EXISTING LAYOUT

NUMBER OF STACKS = 9

EACH STACK = 6 X 16 (40 FT CONTAINERS) X 5 HIGH
= 480 (40 FT CONTAINERS)
= 2 X 6 X 16 X 5 (20 FT CONTAINERS)
= 960 TEUS

POSSIBLE MAXIMUM STORAGE

= 960 X 9 = 8640 CONTAINERS – 20 FT
= 480 X 9 = 4320 CONTAINERS – 40 FT

PROPOSED REVERSE STACKING CONCEPT

SKETCH ATTACHED (NEXT SHEET)

LENGTH = 286.0 M

BREADTH = 234.0 M

DIMENSION OF CELL GUIDE SLOTS FOR

- 40 FT CONTAINERS = 16 M X 4 M
- 20 FT CONTAINERS = 8 M X 4 M
- NUMBER OF ROWS FOR
- 40 FT CONTAINERS = 286 / 16 = 17.875
  APPROX. 18 CONTAINERS
- 20 FT CONTAINERS = 286 / 8 = 35.750
  APPROX. 36 CONTAINERS

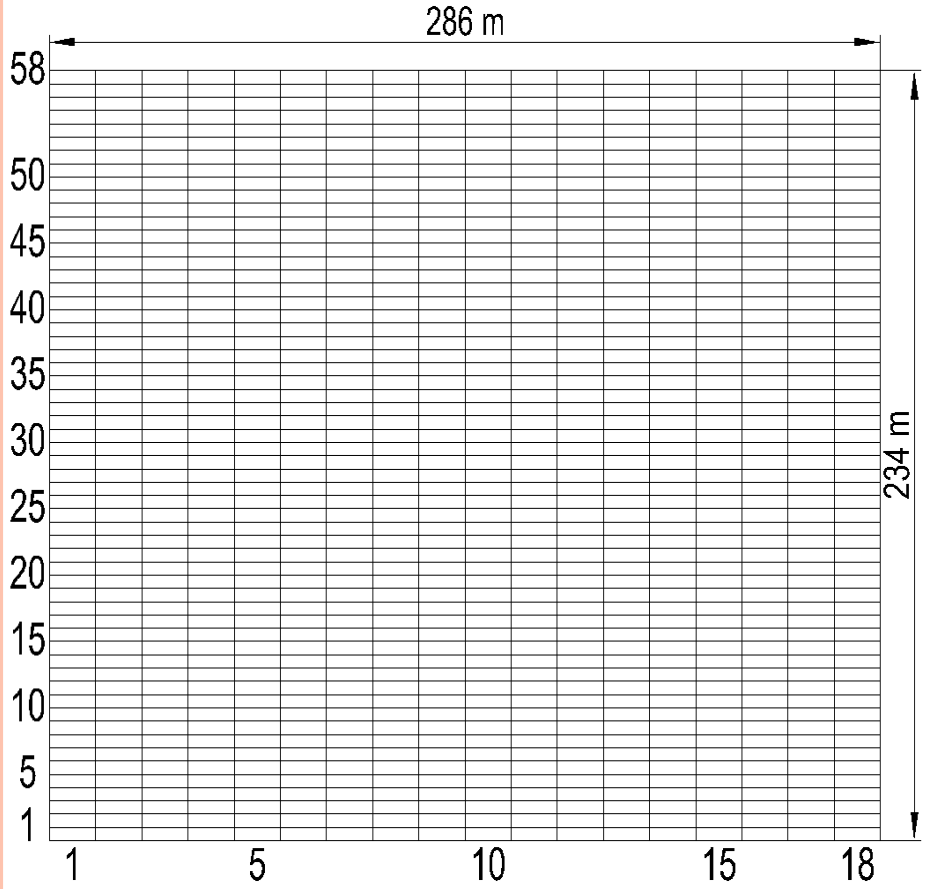
EACH ROW

- 40 FT CONTAINERS = 234 / 4 M = 58.5
  APPROX. 58 CONTAINER SLOTS
- 20 FT CONTAINERS = 234 / 4 M = 58.5 APPROX.
  58 CONTAINERS SLOTS

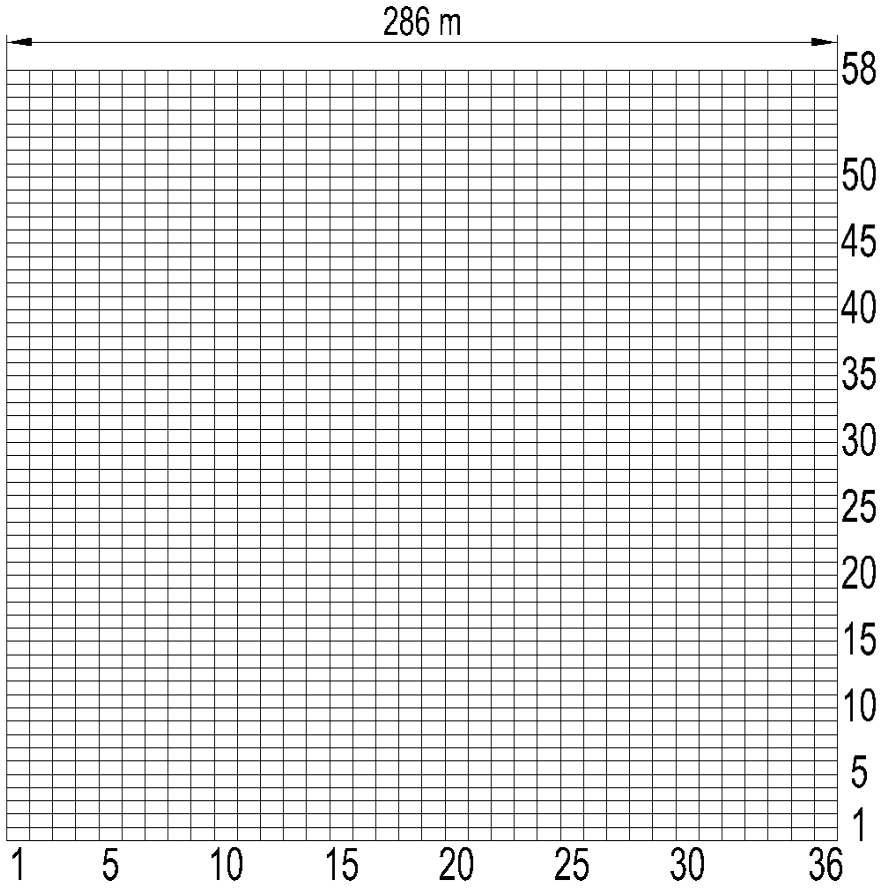
SO TOTAL NUMBER OF SLOTS

- 40 FT CONTAINERS = 18 X 58 = 1044 TEUS
- 20 FT CONTAINERS = 36 X 58 = 2088 TEUS

CONTAINER STORAGE DENSITY COMPARISON SAMPLE AREA IN PASIR PANJANG TERMINAL 3 – SINGAPORE



40 FT CELL GUIDE SLOT (1044 SLOTS)



20 FT CELL GUIDE SLOT (2088 SLOTS)

APPENDIX 6

CONTAINER STORAGE DENSITY COMPARISON SAMPLE AREA IN PASIR PANJANG TERMINAL 3 – SINGAPORE

NO	AVERAGE WEIGHT OF CONTAINERS	ALLOWABLE STACKING HEIGHT		IN 2088 SLOTS	IN 1044 SLOTS	COMPARED TO EXISTING LAYOUT STORAGE 8640 TEUs	
				(3) x 2088	(4) x 2088	(5) / 8640	(6) / 4320
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		20 FT	40 FT	20 FT	40 FT	20 FT (8640)	40 FT (4320)
1	32.5 T (GROSS)	6	6	12528	6264	1.45	1.45
2	EMPTY	83	38	173304	39672	20.88	9.18
3	8.0 T	24	24	50112	25056	5.8	5.8
4	14.0 T	13	13	27144	13572	3.14	3.14

ANIMATION

THANK YOU