	FEDERATION EUROPEENNE DE LA MANUTENTION • PRODUCT GROUP INTRALOGISTIC SYSTEMS • PRODUCT GROUP RACKING & SHELVING	**FEM** **9.831 – 1** **10.3.01 – 1**
	Basis of calculations for storage and retrieval machines - Tolerances, deformations and clearances in the storage system **Part 1: General, Single deep and Double deep Beam Pallet racking**	**October 2012 (E)**

Supersedes FEM 9.831:1995

Index

Continued page 2 to 109

Fédération Européenne de la Manutention (Product Group Intralogistic Systems, Racking & Shelving)

For references see end of document

1 Introduction and Aims

A storage system, operated by Storage/Retrieval (S/R) machines, forms a functional unit consisting of components which are subject to tolerances resulting from manufacture and erection, as well as deformations from operation under load.

S/R machines are designed to store and retrieve unit loads from freely selected locations. Sufficient clearances are one of the important conditions to allow for safe operation. On the one hand, clearances which are too small constitute a risk to operational safety so that handling operations in a warehouse may have to be stopped. On the other hand, useful storage space is wasted where clearances are too large.

The aim of this document is to show the relationship of the individual system components. Permissible practical tolerances and deformations are listed for typical system solutions. The aim is that the values for individual system components will result in clearly defined responsibility in the event of interface problems. The method used is described in clause 7.

The aim of this document is to determine the admissible deformations and tolerances in order to optimise the factors relating to the economical dimensioning, manufacturing and assembly required for the safe operation of the overall system.

In principle it is possible or necessary to deviate from the figures stated in the document, for technical or economic reasons, provided that the functionality of the whole system can be guaranteed. However in this case clear agreements have to be reached regarding the means by which the main aims of this document will be achieved i.e. "to define the interfaces between the components of a high-bay warehouse (see FEM 9.841 / FEM 10.2.10)".

This Code is drafted by a joined Working Group of two FEM Product Groups:

- Intralogistic Systems
- Racking & Shelving

2 Scope

This document is a supplement to FEM 9.841 / FEM 10.2.10 and gives general guidance as well as specific guidance for single and double deep beam pallet racking in the calculation of required minimum clearances and entry clearances in order to provide safe operation, considering effects of tolerances, wear, deformations and displacements.

The rules given in this document apply to high-bay warehouses, both clad rack and free standing racking, served by S/R machines which travel on a floor mounted rail, are stabilized by an upper guide rail, are equipped with a mechanical load handling device, especially a telescopic fork and are suitable for handling pallets or comparable load make-up accessories such as box containers.
General rules are given as well as specific rules and examples which do apply for single deep and double deep pallet racking.

The examples are intended as guidance for the final determination of the required minimum clearances, tolerance limits and maximum deformations to ensure safe operation and are partly based on assumptions which might change per project.

NOTE: For automatic small parts warehouses see FEM 9.832.

3 Definitions

Aisle clearance:
Clearance between

- the outer most edge of the S/R machine and the outer most edge of the rack or the aisle sided unit loads in the rack, or
- the unit load on the S/R machine and the outer most edge of the rack or the aisle sided unit loads in the rack

Auxiliary level:
Vertical or horizontal level without tolerances

Clearance:
Nominal dimension between items, to ensure safe operation, related to a tolerance-free, non deformed system

Coordinate positioning:
Positioning of the S/R machine using global coordinates

Deformation:
Deviation from the basic position due to the effect of forces and wear

Double deep racking:
Racking in which unit loads can be stored two deep from one aisle into the installation and accessed by a specially adapted long reach fork mechanism

Entry clearance:
Clearance between the load handling device and the load make-up accessory or rack structure

Lifting carriage:
Component of the S/R machine supported and guided by the mast and that carries the unit load and is raised or lowered as required.

Load make up accessory (LMA):
e.g. pallet, box container

Location fine positioning:
Local adjustment of the machine's position with respect to the rack components in the X and / or Y directions using sensors on the crane and location devices on the rack

Pick up and deposit (P&D) stations:
Locations used as an interface between different types of mechanical handling equipment

Rack compartment clearance:
Clearance between respective unit loads and the rack structure

Relative depositing tolerance:
shift of pallet

Relocation:
transferring pallets from one rack position to another without centring

Shift of pallet:
A relative depositing tolerance of the unit load resulting from tolerances and deformations of all sub-systems concerned, in down aisle (X-) and cross aisle (Z-) direction with regard to its nominal ("ideal") position in relation to the rack structure.

Single deep racking:
Racking where there is only a single run of unit loads each side of the aisle, which is served by the handling equipment in that aisle

Storage and retrieval (S/R) machines:
Machines, restricted to the rails on which they travel, handling unit loads for the storage and retrieval in rack systems

System axes:
X = Down aisle direction
Y = Vertical direction
Z = Cross aisle direction

System designer (SD) / Planner (FEM 9.223)

the person or institution responsible for the overall design and functionality of the system, this can be the logistic consultant or the general contractor or the client himself and shall be defined on a project by project basis.

NOTE: For more information and responsibilities see FEM 9.223.

System level:
Plane without tolerances in XY direction, XZ direction and YZ direction, defined by clearly marked points or straight lines

Tolerance:
The permissible maximum deviation from nominal dimension or position

Unit load (UL):
load with specified characteristics (e.g. mass, dimensions with their tolerances, pallet or container, quality, packaging, etc.) which the machine has been designed to carry and the storage system has been designed to operate.