

The Double definition of the Transport Index (T.I) : A wrong good idea ?

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INTRODUCTION

The transport index (T.I) was set up at the beginning of the sixties in order to facilitate and make safer the gathering in the same conveyance of a certain number of packages of radioactive and fissile materials.

T.I allows on the one hand to limit the radiation dose rate around the packages to an acceptable value, on the other hand to avoid any possible risk of criticality, both possible consequences of the accumulation of several packages on a conveyance.

In order to simplify the loading and control of its safety a single T.I which covered at the same time the radioactive and fissile aspects without making any difference between the packages was set up.

I THE CURRENT SITUATION

Let us recall the rule : transport index based on radiation exposure control is the maximum radiation level, in mRem/h at a distance of 1 m from the external surface of the package, container or tank (or the value in mSv/h multiplied by 100).

Transport index based on nuclear criticality control shall be $50/N$, N defined by the following paragraph 567.

Arrays of packages

567. An array of packages shall be subcritical. A number 'N' shall be derived assuming that if packages were stacked together in any arrangement with the stack closely reflected on all sides by water 20 cm thick (or its equivalent) both of the following conditions would be satisfied:

- (a) Five times 'N' undamaged packages without anything between the packages would be subcritical; and
- (b) Two times 'N' damaged packages with hydrogenous moderation between packages to the extent which results in the greatest neutron multiplication would be subcritical.

In the case of packages, containers, tanks containing fissile materials, it is the larger of the two Transport Indices, defined hereabove which shall be taken in account.
That is described in the following table VIII of the SS06 Regulations.

TABLE VIII. DETERMINATION OF TRANSPORT INDEX

Item	Contents	Method of determining transport index (TI)
Packages	Non-fissile material	TI for radiation exposure control
	Fissile material	The larger of the TI for radiation exposure control or the TI for nuclear criticality control
Non-rigid overpacks	Packages	Sum of TIs of all packages contained
Rigid overpacks	Packages	The sum of the TIs of all packages contained, or for the original consignor, either the TI for radiation exposure control or the sum of the TIs of all packages
Freight containers	Packages or overpacks	Sum of the TIs of all packages and overpacks contained
	LSA material or SCO	Either the sum of the TIs or the larger of the TI for radiation exposure control or the TI for nuclear criticality control
Freight containers under exclusive use	Packages or overpacks	Either the sum of the TIs or the larger of the TI for radiation exposure control or the TI for nuclear criticality control
Tanks	Non-fissile material	TI for radiation exposure control
	Fissile material	The larger of the TI for radiation exposure control or the TI for nuclear criticality control
Unpackaged	LSA-I and SCO-I	The TI for radiation exposure control

II PROPOSAL OF MODIFICATION

This rule may appear as being very simple, is conservative and protect us in any case from criticality problems.

Nevertheless its implementation may lead to paradoxical and even unpleasant situations because of its lack of accuracy.

Let us indeed consider the table XI of SS06

TABLE XI. TI LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES

Type of freight container or conveyance	Limit on total sum of transport indexes in a single freight container or aboard a conveyance			
	Not under exclusive use		Under exclusive use	
	Non-fissile material	Fissile material	Non-fissile material	Fissile material
Freight container — Small	50	50	n.a.	n.a.
Freight container — Large	50	50	No limit	100
Vehicle	50	50	No limit	100
Aircraft passenger	50	50	n.a.	n.a.
cargo	200	50	No limit	100
Inland waterway vessel	50	50	No limit	100
Seagoing vessel ^a				
1. Hold, compartment or defined deck area:				
packages, overpacks, small freight containers	50	50	No limit	100
large freight containers	200 ^b	50	No limit	100
2. Total vessel:				
packages, etc.	200 ^b	200 ^b	No limit	200 ^c
large freight containers	No limit ^b	No limit ^b	No limit	No limit ^c

^a Packages or overpacks carried in or on a vehicle which are in accordance with the provisions of para. 469 may be transported by vessels provided that they are not removed from the vehicle at any time while on board the vessel.

^b The consignment shall be so handled and stowed that the sum of TIs in any individual group does not exceed 50, and that each group is handled and stowed such that the groups are separated from each other by at least 6 m.

^c The consignment shall be so handled and stowed that the sum of TIs in any individual group does not exceed 100, and that each group is handled and stowed such that the groups are separated from each other by at least 6 m. The intervening space between groups may be occupied by other cargo in accordance with para. 405.

We see that in this table we have on the first hand to consider one T.I, as defined above, on the second hand, to discriminate non fissile and fissile substances. Let us take the example of a vehicle in non exclusive use, carrying non fissile material.

The total T.I is then equal at most to 50.

On the contrary, a vehicle carrying at the same time non fissile and fissile material such as the T.I of each unit of fissile material is the irradiating one (as the larger) can present a T.I going up to 50 for the non fissile material and also until 50 for the fissile material, that is to say a total limited of $50 + 50 = 100$ for the entire cargo, i.e. two times larger because of the fissile character of a part of the cargo.

This paradox comes clearly from the fact that we distinguish fissile and non fissile materials in the limitations, while the unique T.I is aimed at making useless this discrimination. What in this table we are aiming at is in fact for non fissile the radiation hazard, for fissile material the criticality risk.

It would be therefore, more logical to replace in the table XI "non fissile material" by "non fissile T.I" and "fissile material" by "fissile T.I".

That will give the following results :

TABLE XI. TI LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES

Type of freight container or conveyance	Limit on total sum of transport indexes in a single freight container or aboard a conveyance			
	Not under exclusive use		Under exclusive use	
	Non-fissile T.I	Fissile T.I	Non-fissile T.I	Fissile T.I
Freight container — Small	50	50	n.a.	n.a.
Freight container — Large	50	50	No limit	100
Vehicle	50	50	No limit	100
Aircraft				
passenger	50	50	n.a.	n.a.
cargo	200	50	No limit	100
Inland waterway vessel	50	50	No limit	100
Seagoing vessel ^a				
1. Hold, compartment or defined deck area:				
packages, overpacks, small freight containers	50	50	No limit	100
large freight containers	200 ^b	50	No limit	100
2. Total vessel:				
packages, etc.	200 ^b	200 ^b	No limit	200 ^c
large freight containers	No limit ^b	No limit ^b	No limit	No limit ^c

That makes it necessary, to no longer take in account one unique T.I (the larger) but two Transports Indices, the first radioactive the second fissile and to consider their two sums with their own limitations.

Thus, the pure irradiating package, the pure fissile ones, and the ones which are both irradiating and fissile will see their number limited in a more logic and precise way.

Outside this table XI, we know that some limitations are grounded on the T.I. For instance, the United States forbid on board of passenger Aircrafts packages presenting a T.I larger than 3. At the present time, this rule forbid the carriage of fissile packages of such a T.I by these planes without any real justification.

Another example is given in IMO, requiring intervention of the CA when the T.I for a shipment of fissile material exceeds 50. If the larger T.I is the irradiating one, why limit this requirement to fissile material ?

III CONCLUSION

The T.I defined as the larger of irradiating and fissile T.I was justified by the non discrimination between fissile and non fissile packages. The table XI assume on the contrary this discrimination. The combination of this discrimination and of this unique T.I leads to paradoxical and unpleasant results, sometimes opposed to the primary intentions.

Without prejudging of the values which are given in table XI we propose therefore :

- 1) to attribute to any package an irradiating T.I and a fissile T.I.
- 2) To limit the sum of each of these Transports Indices making the simple substitution proposed hereabove in the table XI.
- 3) To adapt the remaining of the Regulations to this situation (e.g table VIII).