Vibration and Shock Measurement During the Transportation of The PFBR Dummy Subassembly along with Cask From the Interim Storage Building to PFBR Fuel Building

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Abstract. As a part of the Prototype Fast Breeder Reactor (PFBR) pre-commissioning activity, a mockup trial run has been carried out for the 6 full scale representative PFBR dummy fuel sub assemblies (FSA) along with cask on the transportation trailer from the Interim fuel storage Building (IFSB), which is located in the Fast Breeder Test Reactor (FBTR) to the Fuel Building (FB), which is located in the Prototype Fast Breeder Reactor (PFBR).. The purpose of this trial was to assess the vibration and shock during the transport of the dummy SA from the IFSB to the PFBR FB. These data were useful in addressing the safety concerns from the vibration and shock points of view during the transportation of the fresh FSA and also to check the acceleration / vibration with reference to NUREG/CR-0128 guidelines. Details about the test arrangements as well as the maximum acceleration found during the transportation are presented in this paper.

Key Words: Shock, Vibration, Transportation Cask, Fuel Subaseembly.

1. Introduction

Demonstration of the safe and secure transportation of fresh subassemblies from Interim fuel storage building (IFSB) to Fuel building (FB) is an important milestone in the pre commissioning activity of PFBR. This requirement calls for the experimental demonstration of the transportation of fresh FSA along with the transportation cask respecting the regulatory requirements. Fresh SA is transported in a shielded flask called fresh fuel transport cask (FFTC) mounted on a custom made transport trailer intended for the same. FFTC can carry a maximum of six SA arranged in a circular pitch of 300mm to maintain the SA in sub critical condition. In order to maintain safe transport of the cask, the same is restrained from moving within or on the low bed trailer during transport operation as per AERB regulations. Tensile tie down connected between the attachment points on the cask and anchor points on the trailer with chock at the bottom to restrict horizontal movement is chosen as the retention system during its transport. The cask retention system is designed for normal conditions of transport.

A pre-survey has been carried out with an empty trailer through the expected route. It gave valuable information regarding the road conditions, geometrical constraints for the trailer movements and facilities at both ends. Based on the learning from the pre-survey corrective actions have been carried out based and subsequently mock-up trial has been performed with full scale representative fuel subassembly (dummy FSA) from the IFSB to FB. This trial has been carried out with proper sensors and instrumentation. During this trial, vibration and shock measurement has been carried out. These data will be useful in addressing the safety concern from the vibration and shock point of view during the transportation of the fresh FSA. This paper presents the results and details about the mockup trial.

2. Mockup trial

Photograph of the mock-up trial arrangement is shown in *FIG.1*. The cask is further tied to the trailer with the help of four slings as shown in *FIG.1* for maintaining the transportation flask in the vertical position. The shielded cask along with 6 dummy SAs weight is around 12000 kg. The FFTC is designed and manufactured to meet the AERB requirements for the normal conditions of transport. The cask is designed for normal conditions of transport as per the AERB guideline [1]. The cask has been checked for the acceleration / vibration during the transport as per NUREG/CR-0128 [2].

FIG. 1. Photograph for the mockup trial transportation arrangement for the dummy fuel subassembly.

2.1.Instrumentation Measures for Vibration / Shock Assessment

Two triaxial accelerometers along with Dewesoft data acquisition have been deployed for the vibration and shock measurements during the transportation. These triaxial accelerotmers are capable of capturing the vibration and shock along all the three orthogonal directions (say X, Y & Z) during the transportation. The location and direction of these accelerometers are indicated as presented in *FIG.2*. One of the triaxial accelerometer (TA 1146 from *FIG.2*) is mounted on the trailer (close to the bottom most portion of the cask) and another triaxial accelerometer (TA 1141) is mounted at the topmost portion of the cask. These two accelerometers are capable of capturing the maximum possible dynamic response which can occur during the mock up trial.

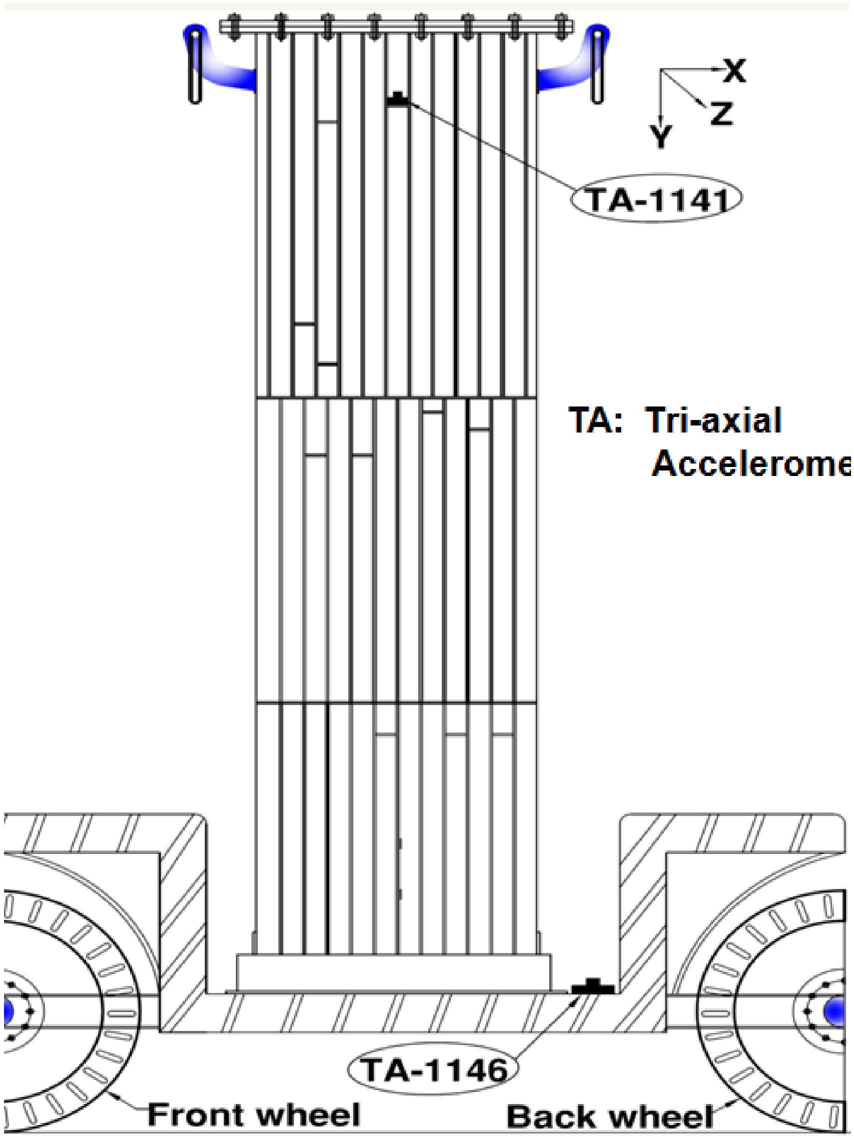

FIG. 2. Schematic of the vibration sensor arrangement for the mockup trial.

2.2.Acceptable Limits of Vibration As per the NUREG [2]

As per the NUREG [2] guideline, the cask has been designed for the following peak acceleration.

- Peak acceleration amplitude along the longitudinal direction : 29 m/s^2
- Peak acceleration amplitude along the vertical direction : 18 m/s^2
- Peak acceleration amplitude along the transverse direction : 13 m/s^2

2.3.Results of the Mock-up Trial

The vibration and shock measurements have been carried out during the onward trip (from the IFSB to FB) as well as the return trip (from the FB to IFSB).The peak acceleration measured on the cask and on the trailer along all the 3 mutually perpendicular directions during the mockup trial has been presented in Figs. 3-6. The Figs. 3 & 4 represent the acceleration response captured during the onward trip (from IFSB to FB) and Figs. 5 & 6 represents the results of the return trip (from FB to IFSB). The summary of those results are tabulated in Table-1.

TABLE 1: Summary of peak acceleration measured during the mock-up trial.

Trip	Location	Peak Acceleration observed (m/s^2)		
		Longitudinal (X - direction)	**Vertical (Y - direction)**	**Transverse (Z - direction)**
Onward trip	Top of the trailer (TA-1146)	19.6	2.1	5.3
	Top of the Cask (TA-1141)	8.9	2.3	3.3
Onward (Ignoring the sudden gear change)	Top of the trailer (TA-1146)	3.5	2.1	5.3
	Top of the Cask (TA-1141)	4.3	2.3	2.7
Return trip	Top of the trailer (TA-1146)	2.8	1.7	3.3
	Top of the Cask (TA-1141)	3.4	2.3	1.9
Max. Acceleration for which the cask has been designed.		29	18	13

The maximum acceleration found during the onward trip at the top of the cask was 8.9 m/s^2 (along the longitudinal direction) and 19.6 m/s^2 (along the longitudinal direction) at the top of the trailer. It is clear from the Fig. 4 that, this shock (19.6 m/s^2), has been detected, during a simulated sudden gear change operation to increase the speed of the trailer from 5-10 km/h to 15-20 km/h. The same has not been observed during the return trip. If we can ignore this sudden speed change, the peak acceleration found from the road condition was 5.3 m/s^2 (at the top of the trailer) and 4.3 m/s^2 (at the top of the cask). The peak acceleration measured during the return trip was 3.3 m/s^2 (at the top of the trailer) and 3.4 m/s^2 (at the top of the cask). These values are due to the unevenness in the prevailing road conditions.

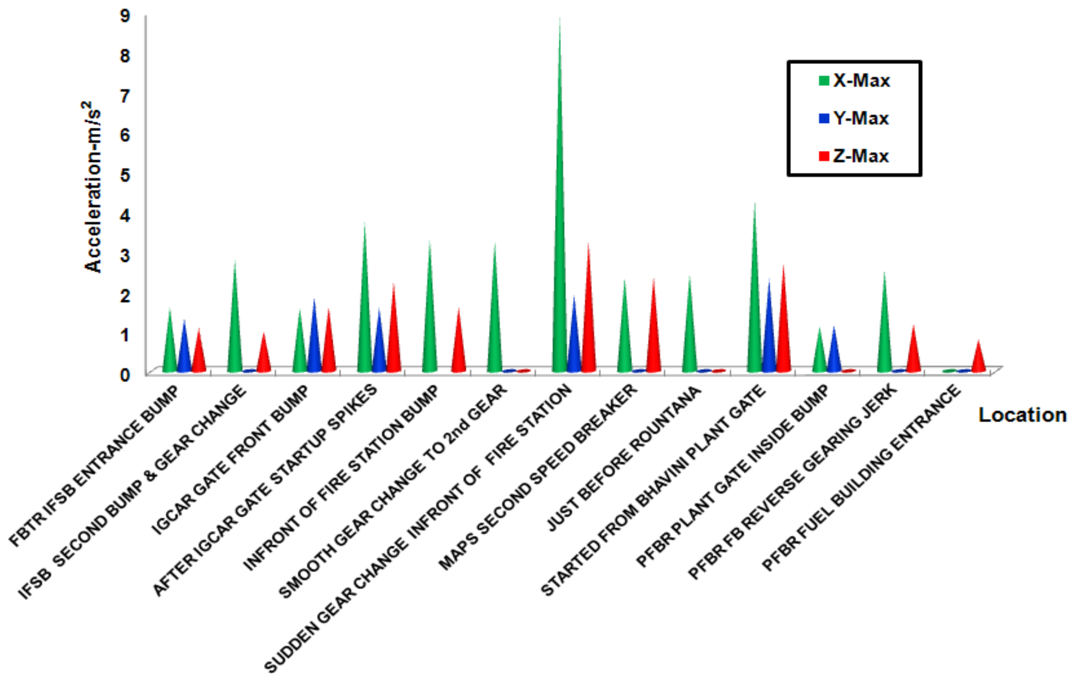

FIG. 3. Shock & vibration measurement at the top of the cask during the onward trip.

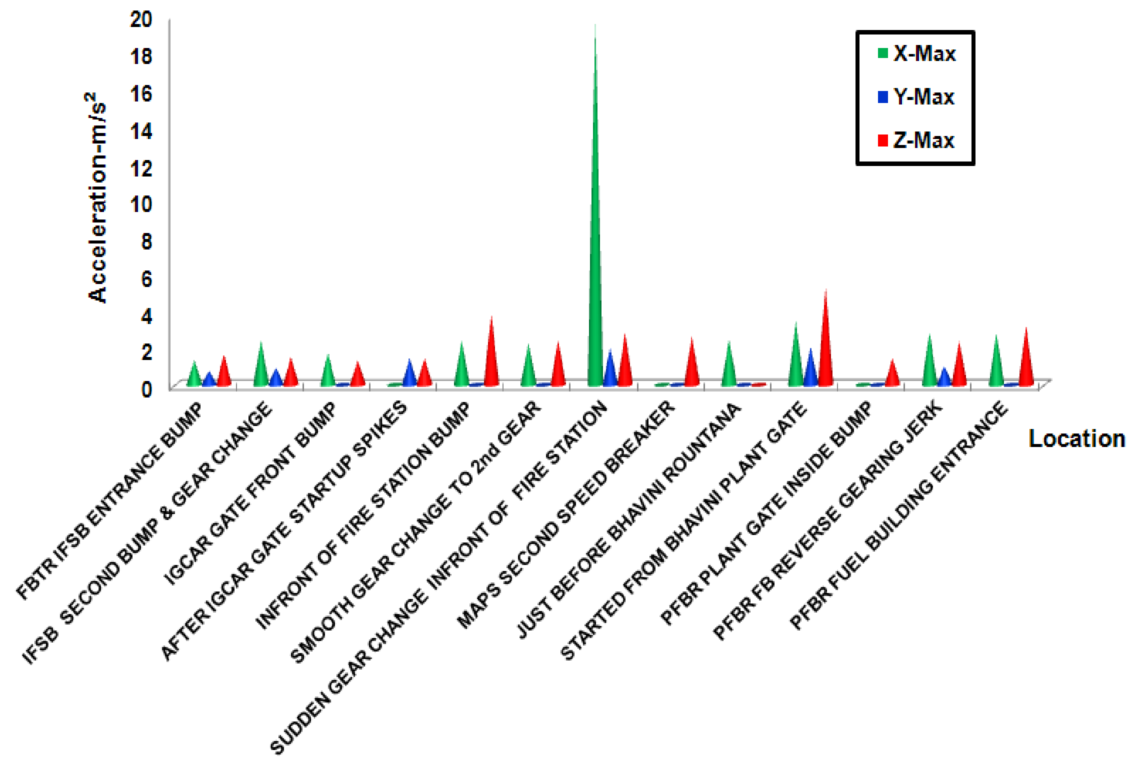

FIG. 4. Shock & vibration measurement at the top of the trailer during the onward trip.

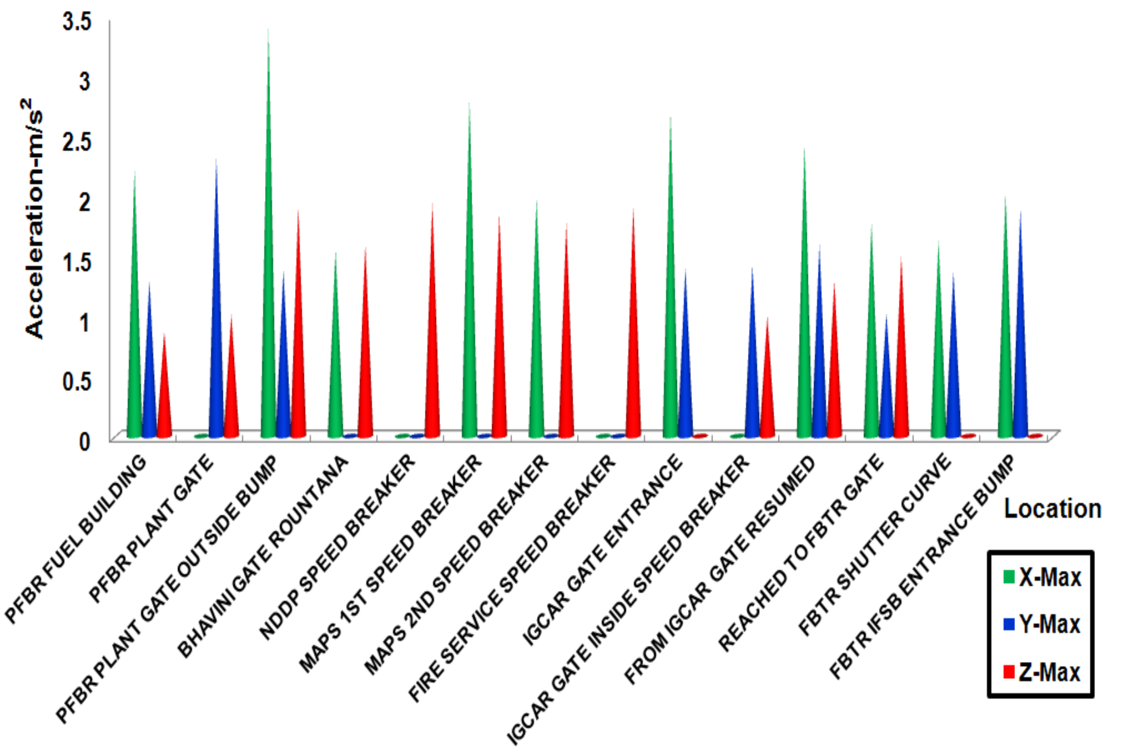

FIG. 5. Shock & vibration measurement at the top of the cask during the returntrip.

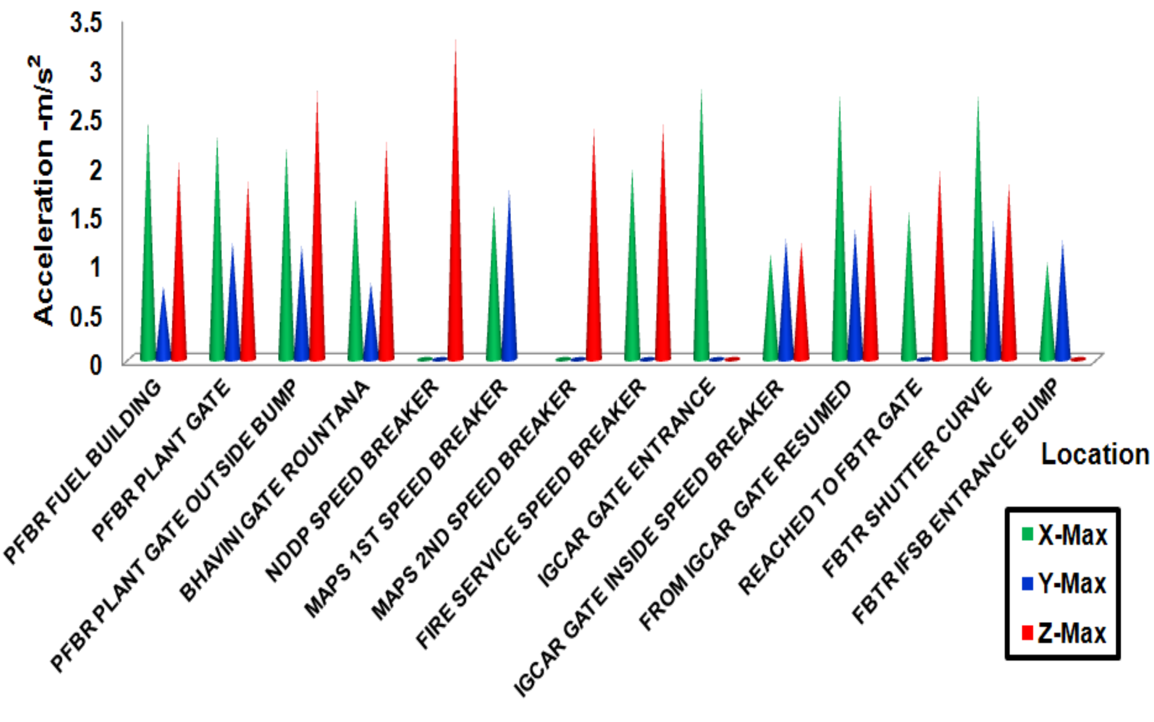

FIG. 6. Shock & vibration measurement at the top of the trailer during the returntrip.

It is clear that, all the above values are lower than the maximum acceleration value for which the cask has been designed. Thus, there is no concern of safety for the transportation of fresh FSA from the IFSB to FB, from vibration and shock point of view.

3. Conclusion

As a part of the pre-commissioning activity, trial run has been carried out for 6 Prototype Fast Breeder Reactor dummy FSA along with cask on the transportation trailer from IFSB to FB and return. Shock and vibration values during the transportations are measured. The maximum acceleration found during the onward trip at the top of the cask was 19.6 m/s^2, which was due to the simulated sudden gear change by the driver. If we can ignore this driving scenario, the peak acceleration found due to the unevenness in the road condition was 5.3 m/s^2. Since all the above values are lower than the maximum acceleration value for which the cask has been designed, there is no concern of safety for the transportation of fresh FSA from the IFSB to FB, from vibration and shock points of view.

Reference

[1] "Code for safety in transport of radioactive materials”, AERB Code No. SC/TR-1, 1986.

[2] “Methods for impact analysis of Shipping Containers”, NUREG/CR-0128, 1978.

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