11/7/02

2.0 PLANE IMPACT SCENARIOS

a. Plane Selection

The scope of this study is directed toward the evaluation of the vulnerabilities of spent fuel transportation casks and dry spent fuel storage casks to intentionally directed flights that result in crashes of large commercial jetliners into a cask or a cask array. Many parameters enter into the description of a defined scenario other than the velocity such aircraft can attain that can be considered in a specific study and evaluation effort with another one of the important parameters being the aircraft used for study. One method of classifying the world-wide family of large commercial jetliners is to simply group them as either single-aisle or double-aisle commercial passenger jetliners. This classification system recognizes in general terms the relative size (cross-section) of the fuselage and hence the aircraft. In some sense this also categorizes aircraft by mass. Another parameter to be considered in any such study includes identifying the manufacturer and the specific model of the aircraft.

World-wide the population of aircraft in the class of large commercial jetliners is dominated (?) by the models manufactured by the Boeing Aircraft Company. Classifying the Boeing aircraft into the single-aisle and double-aisle categories results in the following lists of aircraft in each category for those models with a significant number currently in operation.

Single-aisle: Boeing 717, 727, 737 and 757 models (maximum take-off weight XXX,XXX to XXX,XXX lbs.)

Double-aisle: Boeing 747, 767 and 777 models (maximum take-off weight 395,000 to 910,000 lbs.)

The recent 9/11/01 events in which large commercial passenger aircraft were commandeered and flight controls taken over by individuals who directed the aircraft into civilian targets and military targets were executed using the Boeing 757 and 767 class aircraft. These models It should be noted that these Ex 2
two Boeing models share identical flight control systems so that a pilot for one can also easily pilot the other aircraft. The Boeing 757, with a reputation of being the cheapest aircraft for airlines to operate, is the work horse of airlines worldwide.

Previous analytical work had been performed by SNL that had included an analytical representation of a model aircraft suitable for use with structural analysis computer software is based on information sources that do not include the Boeing Company, but rely on other sources to obtain physical information that could be used to develop an analytical model. Because of the need for expedient commencement of the vulnerability studies, the NRC staff decision was made to use the aircraft as the crash aircraft. Ex 2
A contract has been established by SNL with the Boeing Aircraft Company, to confirm the adequacy of the aircraft analytical model being used and for NRC's intended purpose. In the future as necessary, it may be possible to obtain data that may relate to aircraft such as for the larger model series of aircraft. In addition to being the most expedient analytical model available for study, the model series currently being analyzed also represents the events and therefore represents a realistic aircraft for the study effort.

Although there are larger and heavier aircraft than the the staff decided that the Ex 2

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expedient approach to began the vulnerability assessments for the spent fuel transportation and dry spent fuel storage casks was to use the existing work that had been completed in the creation of an analytical model of an aircraft as the beginning basis. Effort would then be made to improve the analytical model characteristics so as to more closely represent an actual aircraft. Consequently, the ( ) was selected as the study model. (This also represented an aircraft that had actually been used in such a deliberate crash event. Ex 2

b. Analytical Model of Plane

The initial model of the ( ) aircraft that is a finite element model was developed by reviewing information available in the open literature. Such information allows the development of the physical dimensions and to define the external surfaces of the structure. Similar information provides information of on the materials and the mass of the various elements of the aircraft. A model for analytical simulations of crash scenarios must have the capability of allowing the study of the global response as well as the localized response, either of which may identify the most vulnerable behavior to a particular crash scenario under study. Based on the available information, SNL has developed the finite element model that incorporates this geometry, the mass of the aircraft along with a stiffness of the aircraft structure. It has been used at SNL extensively for many of the current vulnerability studies being conducted at SNL. However, several important aspects of truly representative modeling, such as mass distribution of elements within the aircraft structure, accurate location and geometry of the hard or resistant components, etc. still need to be verified and perhaps refined. Ex 2

In order to verify and improve this current finite element model of the ( ) an effort is underway with the Boeing Aircraft Company to examine the current state of the SNL aircraft ( ) model. However, based on the contract provisions, the information to be provided by Boeing will not be specific to a particular model/type of aircraft, rather the information will be for a "generic" large jetliner. This current effort in working with Boeing may result in a new analytical model for the ( ) aircraft being used in the assessments. Such a model is expected to have additional mass and have a different mass distribution within the model structure. Additionally, it is expected that the stiffness of the model structure may change as a result of more detailed knowledge relative to the connection rigidity between various elements important to the vulnerability assessment such as between the wing and the fuselage and the landing gear assembly and the airframe. SNL intends to rerun the jetliner crash calculations using the new model of the aircraft developed as a result of the process. The results of these computer simulations may enable the staff to address the vulnerability of the casks from aircraft impact on a generic basis. If such is not the case, other aircraft may need to be studied based on other threat information or management decisions. Ex 2

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