

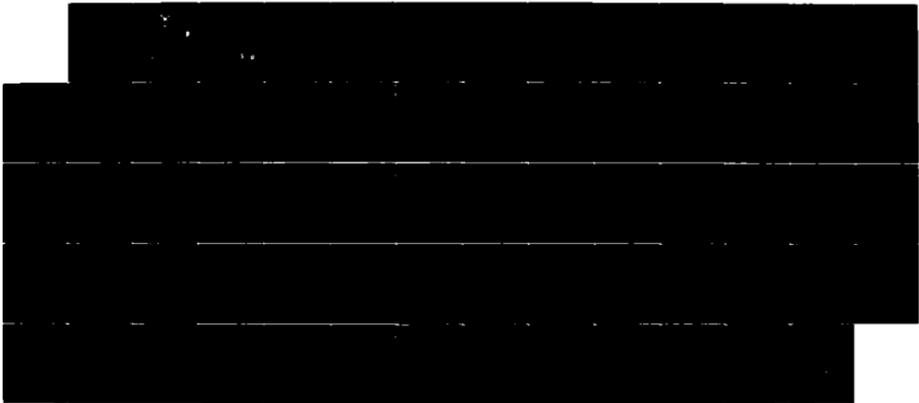
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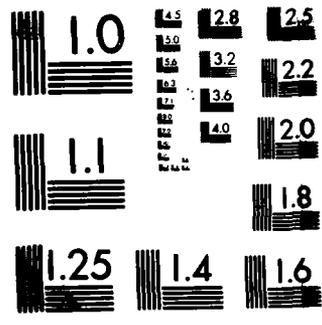
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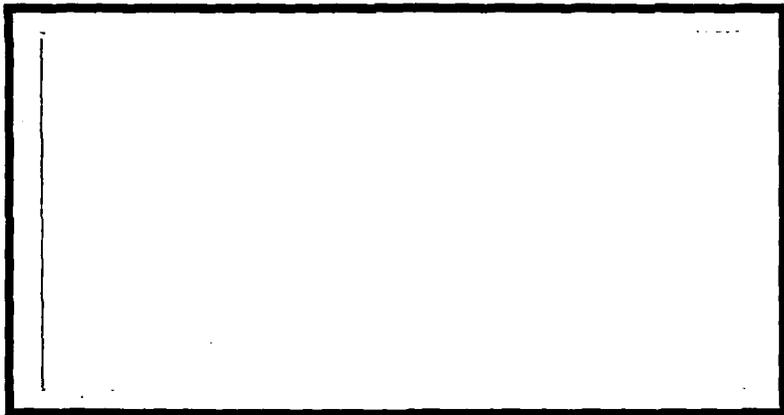
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AN ANALYSIS OF THE AVAILABILITY OF  
VEHICLE NUCLEAR CERTIFICATION INFORMATION  
FOR VEHICLE MAINTENANCE FUNCTIONS

THESIS

Wayne F. Berg, Jr.  
Captain, USAF  
AFIT/GLM/LSMA/87S-4

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AN ANALYSIS OF THE AVAILABILITY  
OF VEHICLE NUCLEAR CERTIFICATION INFORMATION  
FOR VEHICLE MAINTENANCE FUNCTIONS

THESIS

Presented to the Faculty of the School of Systems  
and Logistics of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the  
Requirements for the Degree of  
Master of Science in Logistics Management

Wayne F. Berg, Jr., B.S.

Captain, USAF

September 1987

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## Preface

Having been on the bottom end of the vehicle nuclear certification information ladder, I had found it difficult to deal with a critical area for which it appeared the "system" had not provided me many facts. In conversations with my peers I found I was not alone, and they too had found little information with which to supplement their knowledge so they could make informed decisions. The purpose of this study was to consolidate some of that illusive information in one place so it would be easier to find. Oddly enough, though the roots for why we try to do what we do in regards to nuclear certification were pretty easy to examine, pinning down the logic for what we end up doing was not. I believe the real reason nobody in the field really seems to have a handle on nuclear certification of vehicles, is because we haven't structured the effort for all the right people to be involved. We have a lot of smart mechanics in the maintenance shops who's support isn't being used because they aren't fully aware of the program.

I am indebted for assistance and guidance in my effort to my faculty advisor, Major Kent Gourdin. Additionally, I owe a vote of thanks to my peers at AFIT. Finally, thank you Laura for assistance and motivation.

Wayne F. Berg, Jr.

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Abstract

The objective of this study was to analyze the amount of vehicle nuclear certification information available and to consolidate information pertinent to maintaining USAF vehicles under the guidelines of the Nuclear Weapons Surety Program into a single body of knowledge on which informed maintenance, policy, and inspection decisions could be made. The study examined Federal, DoD and Air Force guidance as it pertained to the purchase, employment and maintenance of noncombat delivery vehicles. Analysis of the guidance revealed the conceptual differences between Federal and DoD policy (emphasis on packaging versus emphasis on vehicle), and the comprehensiveness of the Air Force guidance at time of purchase versus the minimal employment and maintenance guidance to assure the long term certification of the vehicles. Recommendations included enhanced training for mechanics and increased involvement of maintenance management to facilitate assurance of the long term certification of vehicles.

AN ANALYSIS OF THE AVAILABILITY  
OF VEHICLE NUCLEAR CERTIFICATION INFORMATION  
FOR VEHICLE MAINTENANCE FUNCTIONS

I. Introduction

General Issue

Specialized and general purpose vehicles that are involved in supporting nuclear military activities are required to be nuclear certified. Nuclear certification may involve mechanical redundancy or structural modification for most vehicles, and is normally required at time of purchase if the vehicle's anticipated use will relate to nuclear weapons. Commercially designed general purpose vehicles that meet the specifications are afforded "blanket" certification (19:4). When performing routine maintenance or damage repair on these vehicles, those characteristics must then be considered so that the certification is not unknowingly voided, safety compromised, or the nuclear deterrent mission of the USAF impaired. Thus, all USAF activities pertaining to the safe storage, movement, employment, and handling of nuclear weapons contribute to attaining the goals of the Nuclear Weapons Surety Program. However, as identified by James R. Holmes, Nuclear Surety Coordinator, Vehicle Management Division,

Warner-Robins Air Logistics Center, an information gap may exist between the certification efforts made at time of purchase and the eventual maintenance activities performed at the user level (24).

#### Problem Statement

A general lack of vehicle nuclear certification information and, specifically, its limited availability to those performing vehicle maintenance or repair functions may be affecting compliance with the Nuclear Weapons Surety Program.

#### Purpose of Study

The objective of this study was to analyze the amount of vehicle nuclear certification information available and to consolidate information pertinent to maintaining USAF vehicles under the guidelines of the Nuclear Weapons Surety Program into a single body of knowledge on which informed maintenance, policy, and inspection decisions may be made.

#### Background

The Department of Defense policy statement as it appears in AFR 122-3, the Air Force Nuclear Certification Safety Program, characterizes the documented basis of the USAF Nuclear Weapons Surety Program.

Department of Defense Policy. Nuclear weapons require special protection because of their military importance, their destructive power, their cost, and the consequences of an unauthorized or accidental nuclear or high-explosive detonation. They must

be protected against the risks and threats inherent in their environment and must not be subjected to adverse environments, except when such exposure is dictated by operational requirements. The conservation of nuclear weapons as a national resource and the safety of the public, operating personnel, and property are of paramount importance during any operation or movement activity that involves nuclear weapons [14:2].

As a result, implementing policies have been established to facilitate this position. In regards to vehicles, these implementing policies can be grouped into three main categories; purchase, employment, and maintenance.

Purchase. Specific acquisition procedures have been developed for use when purchasing vehicles and equipment requiring nuclear certification. The procedures include structural stress standards for normal and dynamic loads, brake/slope relationships, redundancy requirements, override and drop limits for lifting equipment, synchronization and pressure release requirements for hydraulic units, and numerous specific demands for special purpose vehicles (15). The testing of nuclear certified equipment before acceptance includes evaluation of up to 110% of rated load or performance criteria. Requests for certification of equipment not previously recognized as certified involve an engineering evaluation by Air Force Logistics Command Reliability and Maintainability Engineering Branch (AFLC/MMVRS). Publication of technical orders (TOs) is recognized as evidence of these tests/evaluations because

the TO is expected to consider the nuclear certification impact of the procedures it includes (13; 7).

Employment. Evaluation of the employment of nuclear certified vehicles and equipment is included as a critical item during the Nuclear Surety Inspection (NSI). In fact, a unit will be rated unsatisfactory if uncertified equipment is used during a nuclear weapons transaction or if a weapon could be damaged or rendered unsafe because of the condition of handling equipment (14:23; 12).

Maintenance. The maintenance aspect of the implementation policies includes not only the physical scheduled/unscheduled repair or preventative maintenance performed at the organizational level, but also the training programs for the mechanics, and the modification and deficiency reporting procedures.

However, the relationship between the repair standards, training, and procedures, and the original nuclear certification specifications becomes vague because of guidance originating in AFR 122-3, The Air Force Nuclear Safety Certification Program.

The maintenance standards for the certified design of an equipment item are the same as those for noncertified design. There are no unique or separate nuclear safety maintenance standards [14:4].

#### Investigative Questions

The following investigative questions have been constructed to assist in the analysis of the problem. They

are intended to provide direction for the study, but should not be considered limiting factors.

1. What are the basic vehicle nuclear certification standards imposed by the federal government and incorporated in the USAF Nuclear Weapons Surety Program?
2. How extensive is the training currently provided to vehicle maintenance personnel and managers in regards to nuclear certified vehicles?
3. How extensive is the impact of the nuclear certification requirements on the purchase of special or general purpose vehicles by the USAF?
4. What is the historic approach that the USAF has taken in monitoring the maintenance of nuclear certified vehicles, and what is the current NSI approach to the same?

#### Scope

Two primary limitations are noted in regards to this study. First, the study only applies to USAF nuclear certified vehicles and equipment as defined in the definitions section of this chapter. It does not attempt to address the certification of special test equipment or vehicle type assets excepted by the definition. Second, the study does not attempt to examine the training materials or guidance that may be developed at local levels in the subject area. The study is limited to only those official documents and directives developed for training or guidance at the major command level and above. These limitations are imposed so that the conclusions of the study may be applicable over the widest USAF spectrum possible, but only

as they pertain to formal, base level vehicle maintenance functions.

### Definitions

The following definitions are applicable to this study.

Noncombat Delivery Vehicle. Any vehicle or support equipment officially eligible for use in moving or handling nuclear weapons in a manner other than combat delivery for detonation.

Nuclear Certification. Status wherein vehicles and support equipment are considered to have met the appropriate requirements such that they may be used in conjunction with nuclear weapons. It is synonymous with nuclear safety certification.

Vehicle and Support Equipment. Those vehicles or support equipment items that are provided maintenance through a formal, base level vehicle maintenance organization under the guidance of AFM 77-310, Volume II.

### Methodology.

The data for this study was obtained via two prime methods: an extensive literature review and selective informal interviews of experts in the subject area.

Literature Review Description. The literature review included an examination of Federal, Department of Defense (DoD), and USAF directives pertaining to the nuclear certification of vehicles. Particular emphasis was placed on reviewing background materials leading to the preparation of the USAF nuclear certification safety regulations (122 series) and the AFLC purchase criteria. General vehicle specification data at Warner Robins Air Logistics Center vehicle engineering division, and basic nuclear safety

specifications for vehicles as compiled by the Air Force Weapons Laboratory (AFSC) at Kirtland AFB were also reviewed. Vehicle maintenance technical orders, particularly TO 00-110N-16, were examined for pertinent references to the vehicle specifications utilized at the time of vehicle purchase or nuclear certification. All official USAF vehicle maintenance training materials (CDCs and technical school materials) were reviewed for pertinent references relating maintenance to the vehicle specifications utilized at the time of vehicle purchase or nuclear certification. Data collected during the review of literature was used to answer investigative questions one, two, and three.

1. What are the basic vehicle nuclear certification standards imposed by the Federal government as incorporated in the USAF Nuclear Surety Program?
2. How extensive is the training currently provided to vehicle maintenance personnel in regards to nuclear certified vehicles?
3. How extensive is the impact of nuclear certification requirements on the purchase of special or general purpose vehicles by the USAF?

Selective Interviews Description. Informal interviews were conducted with experts in the area of study. The USAF Nuclear Surety Inspection (NSI) director (dq AFISC/IGP), responsible for the overall vehicle nuclear certification segment of the NSI for HQs Military Airlift Command (MAC), Strategic Air Command (SAC), US Air Forces Europe (USAFE), Pacific Air Forces (PACAF), Tactical Air Command (TAC), Air

Force Systems Command (AFSC), and Air Force Logistics Command (AFLC) was interviewed. The Nuclear Surety Coordinator of the Vehicle Management Division at Warner-Robins Air Logistics Center, Robins AFB, GA, and the Nuclear Certification Manager at the Air Force Weapons Laboratory, Kirtland AFB, NM, were also interviewed. The interviews were channeled to answer investigative question four.

4. What is the historic approach that the USAF has taken in monitoring the maintenance of nuclear certified vehicles, and what is the current NSI approach to the same?

Any literature sources subsequently discovered through the interview process were examined and added to the literature review.

#### Summary

Thusfar, the specific problem to be studied, the objectives of the study, a brief background relating the importance of the area, and the methodology used to investigate the problem have been presented. Though the brief background provided a logical categorization of the Nuclear Weapons Surety Program implementation policies as they relate to vehicles, it also indicated the complexity of the issues contributing to the formulation of those policies. The background presented in Chapter II clarifies the interaction and source of those contributory issues, as well as the specific policies themselves.

## II. Background

A clear understanding of the Air Force nuclear safety perspective requires a background in the federal and Department of Defense (DoD) standards on which it is based. Logic indicates that procedures and methods associated with nuclear materials would be scrupulously detailed and comprehensive. This guidance is provided via a series of legislative enactments, agency standards, DoD directives, and Air Force regulations. This chapter will address each of these areas to provide an insight into the current guidance they provide.

### Federal Guidance

The Hazardous Materials Transportation Act (HMTA) of 1975 is the primary Federal law governing the transportation of a wide range of hazardous materials (31:iii). The act was an attempt to generally recognize the risks to people and property, establish a federal policy on the overall transportation of hazardous materials and wastes, and aid in their identification and categorization. Regulatory responsibilities were primarily placed with three agencies; the Department of Transportation (DOT), the Nuclear Regulatory Commission (NRC), and the Environmental Protection Agency (EPA). Nonregulatory responsibilities fall to a number of "expert" agencies, including the DoD and

Department of Energy (DOE) (31:7). The HMTA has remained virtually unchanged.

Risk Assessment. In terms of the HMTA, risk assessment is primarily a statistical transaction developed by analyzing the hazardous materials data accumulated by the regulatory agencies.

Public concern is greatest about risks that are involuntary, uncontrolled, unfamiliar, immediate manmade, and catastrophic. Hazardous material transportation possesses many and sometimes all of these attributes. Risk assessments can help to address two fundamental questions, one quantitative and objective and one qualitative and subjective [31:43].

Databases of various types are maintained by regulatory and various state agencies on accidents, materials routing and basic industry information. The assignment of database collection responsibilities in the HMTA attempts to provide a statistical source on which both types of questions identified in the previous quote can be addressed. The three principle Federal databases available for vehicle (truck) flow analyses are the Commodity Transportation Survey (CTS), and the Truck Inventory and Use Surveys of 1977 and 1982. All three sources were compiled by the Bureau of the Census (31:48) and used by the DOT and NRC in conjunction with various accident, routing and industry information databases to assess risks.

Policy. The HMTA clarified the Federal role in hazardous materials transportation as essentially being regulation, enforcement, emergency response, and data

collection/analysis (31:7). The key regulatory agencies, as previously mentioned, are the DOT, EPA, and NRC. Through a series of Memoranda of Understanding, the responsibility for particular areas have been divided among these agencies (29:413). The agencies subsequently changed or expanded hazardous materials transportation regulations with emphasis on container specifications, routing and reporting requirements, classification of materials, and data collection/analysis. Emergency response is the responsibility of several DOT agencies, the Federal Emergency Management Agency (FEMA) and the EPA (31:5).

Classification. The classification of hazardous materials can be found in Title 49 of the Code of Federal Regulations (6). More than 30,000 hazardous materials are recognized in the code and are subject to regulation. The code specifies labeling, packaging, and mode requirements (6).

For the purpose of this study, the two key regulatory agencies pertaining to vehicles, and nuclear safety certification are the DOT and the NRC. Therefore, each agency warrants closer review.

#### Department of Transportation (DOT)

As a result of the Department of Transportation Act of 1966, the DOT was organized. It assumed authority to regulate hazardous materials from the Interstate Commerce Commission (ICC), the Department of the Treasury, and the

Civil Aeronautics Board (CAB). Under the new structure, modal regulatory integrity was retained by having the DOTs Federal Aviation Administration (FAA) regulate air, the Federal Highways and Railroad Administration for land, and the Coast Guard for water. A separate DOT entity, the Office of Hazardous Materials, was formed to coordinate hazardous material issues within the department (31:147).

Legislation pertaining to hazardous materials transportation was passed in 1970, however, implementation difficulties within the DOT lead to their inclusion in the sweeping Hazardous Materials Transportation Act of 1975 (HMTA) referred to previously. Broad authority was included in the HMTA to transcend modal bounds with regulation.

Specifically, the HMTA of 1975:

expanded DOT's potential jurisdiction to any traffic "affecting" interstate commerce (49 USC 1802);

authorized the designation of hazardous materials, defined as materials or classes of materials in quantities and forms that the Secretary of Transportation determines may pose an unreasonable risk to health and safety or property (49 USC 1803);

authorized DOT to issue regulations related to packing, repacking, handling, labeling, marking, placarding, and routing; and expanded the regulated community to include those who manufacture, test, maintain, and recondition containers or packages used to transport hazardous materials (49 USC 1804);

authorized the establishment of a registration program for shippers, carriers, and container manufacturers and reconditioners (49 USC 1805);

codified DOT procedures for granting regulatory exemptions (49 USC 1806);

provided the Secretary with the ability to conduct

surveillance activities (e.g., hold hearings and conduct investigations), establish record keeping requirements, and conduct inspections. Provisions of the 1970 Act were also included in this section of the HMTA, such as submission of an annual report to Congress (49 USC 1808);

authorized DOT to assess civil and criminal penalties for violations of the HMTA (49 USC 1809); and

defined the relationship between the Federal regulations and those State and local governments, preempting non-Federal rules found to be inconsistent with the Federal program and establishing a procedure whereby DOT could waive preemption (49 USC 1811).

(31: 148)

The Materials Transportation Bureau (MTB), within the DOT's Research and Special Programs Administration (RSPA), was subsequently designated the lead agency for hazardous materials as a result of the HMTA. In 1976, the MTB consolidated and amended the hazardous materials regulations based on changes originally proposed in the late 1960's prior to passage of the HMTA. "The format of the regulations has essentially remained the same since 1975 (31:148)."

Under its authority, DOT has issued regulations covering all aspects of transporting radioactive materials, including the containers, the mechanical condition of the transportation vehicles, and the training of personnel, as well as the routing requirements, package labels, vehicle placards, and shipping papers [31: 27].

Additionally, under DOT regulations, both the DOE and DoD have authority to approve aspects of radioactive material transport particular to their functions. Both agencies, however, are required to use standards and methods equivalent to DOT and NRC procedures (31:27).

### Nuclear Regulatory Commission (NRC)

The NRC was formed under the Energy Reorganization Act of 1974 to encompass most activities previously handled by the US Atomic Energy Commission (AEC). The prime functions of the NRC include management of nuclear research, licensing/monitoring of nuclear power plants, and aspects of nuclear waste management (28:102-109). As a result of the HMTA, and the DOT Memoranda of Understanding previously mentioned, the NRC also has a regulatory responsibility for the transportation of radioactive materials.

The NRC is primarily concerned with reviewing and certifying designs of packaging for all quantities of fissile materials and for significant quantities of other radioactive materials [28:107].

Radioactive container requirements are specified in Title 10 of the Code of Federal Regulations, Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions. Included are criteria specifications such as the three to one safety margin for lifting/packaging strength and the ten to one ratio for tie down restraints.

Two major analyses have been conducted by the NRC which address specific aspects of transporting nuclear materials; WASH-1238, Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants; and, NUREG-0170, Final Environment Statement on the Transportation of Radioactive Material by Air and Other

Modes. Though each are over a decade old, they are still primary sources for NRC policy/guidance (30).

WASH-1238. Part 51.20, 10 CFR, which deals with such general transport issues as escort, routing, and load limit requirements for radioactive materials was promulgated largely by WASH-1238. The analysis provided by WASH-1238 determined that the environmental risk of radiological effects stemming from surface transportation accidents was small (28:109). "Primary reliance for safety in transport of radioactive material is placed on the packaging (32:4)." As a result, WASH-1238 concentrated its appraisals of transportation risks in relation to the emphasis placed on containers and packaging.

NUREG-0170, Volumes I and II. In 1977, the NRC conducted a complete reevaluation of its regulations concerning transportation of radioactive materials, particularly in light of the impact of the HMTA. Specifically, the analysis looked at HMTA inconsistencies with state and local regulations, security concerns, overall risk assessment, and risk assessments for each mode of transportation (air, motor/rail, water). The study validated current regulation goals with emphasis on container design in relation to mode, routing as a method of reducing public exposure, and the intended preemptive effect of the HMTA on state and local regulations. In addition, the analysis consolidated some guidance provided in other NRC

publications (such as NUREG-0034) and incorporated suggestions from other federal agencies and private sector contributors, such that it became a more complete guide (32).

#### DoD Guidance

As noted previously, the DoD is a nonregulatory agency authorized by the DOT and NRC to monitor hazardous material management particular to its function. It is recognized that neither the Atomic Energy Act of 1954 (which formed the AEC, forerunner of the NRC) nor the Energy Reorganization Act of 1974 (which formed the NRC) were intended to affect military or national security based transportation of nuclear weapons (28:323). Largely, the DOT and NRC acknowledged the same freedom of reporting nuclear weapons movement (33:8-26), while still stipulating compliance with safety standards.

The DoD implements its policies through Department of Defense Directives (DODDs) which are essentially department laws with which the military departments (Army, Air Force, etc) must comply. The vehicular aspects of nuclear weapons transportation are addressed in three directives; DODD 3150.2, DODD 4540.5, and DODD 5210.41.

DODD 3150.2. Safety Studies and Review of Nuclear Weapons Systems, as the directive is titled, establishes the DoD policy, responsibility assignments, and procedures to: apply safety standards to nuclear weapons and systems,

develop and process nuclear weapons safety rules, and conduct safety studies and operational safety reviews of nuclear weapons systems.

The goal of nuclear weapons safety studies, reviews, rules, and procedures is to ensure that nuclear weapons and nuclear weapons systems are designed, maintained, transported, stored, and employed to incorporate maximum safety consistent with operational requirements [7:2].

Specifically, the directive places the responsibility for establishment and issuance of safety design and evaluation criteria for nuclear weapons systems with the Secretary of each military department. Most importantly, the directive introduces the four Nuclear Weapons System Safety Standards on which all specific guidance is to be based, and the associated impact of the stockpile-to-target sequence.

The four Nuclear Weapon System Safety Standards are as follows:

1. There shall be positive measures to prevent nuclear weapons involved in accidents or incidents, or jettisoned weapons, from producing a nuclear yield.
2. There shall be positive measures to prevent DELIBERATE prearming, arming, launching, firing, or releasing of nuclear weapons, except upon execution of emergency war orders or when directed by competent authority.
3. There shall be positive measures to prevent INADVERTENT prearming, arming, launching, firing, or releasing of nuclear weapons in all normal and credible abnormal environments.
4. There shall be positive measures to ensure adequate security of nuclear weapons, pursuant to DoD Directive 5210.41.

(7:2-1)

The stockpile-to-target sequence is the analysis concept wherein all aspects of a nuclear weapon system are considered against support equipment, maintenance, and production requirements/impacts. The concept is the prime arena of the Nuclear Weapons Systems Safety Group (NWSSG). The NWSSG is the functional representation of the fourth Nuclear Weapons System Safety Standard.

Finally, the directive specified that stockpile-to-target sequence procedures will be in the form of military department approved technical data or technical orders (TOs) that are validated as safe before publication. Joint service TOs are to be utilized where appropriate (7).

DODD 4540.5. This Movement of Nuclear Weapons by Noncombat Delivery Vehicles directive establishes the policy and criteria for the movement of nuclear weapons and components by noncombat delivery vehicles; assigns responsibility for publication of joint manuals on uniform weapon inspection criteria and custody/accountability procedures; and consolidates procedures previously included in two other directives, DODD 4540.3 and DODD 4540.4.

Whereas DODD 3150.2 introduced the Nuclear Weapon Systems Safety Standards, DODD 4540.5 effects implementation by introducing the concept of nuclear safety certification.

U.S. and non-U.S., noncombat delivery vehicle support equipment and procedures shall receive a safety certification prior to being authorized for nuclear

weapons handling operations. Safety certification criteria and procedures shall be developed by the Military Departments [8:3].

In addition, DODD 4540.5 specifically "does not abrogate or abridge the authority or responsibility of a commander to deviate in an emergency from the policies and criteria established here ...(8:2)."

DODD 5210.4. This directive, entitled Security Criteria and Standards for Protecting Nuclear Weapons, was specifically identified in the fourth Nuclear Weapon System Safety Standard introduced in DODD 3150.2. Though primarily concerned with security issues, such as the two-man concept, it also mentions protection from environmental influences and the training requirements of personnel directly supporting nuclear weapons activities.

US Air Force Guidance.

As specified in DODD 3150.2, the Secretary of the Military Department is responsible for insuring development and issuance of safety design and evaluation criteria for nuclear weapons systems. Accordingly, the Department of the Air Force has issued criteria and procedures, primarily through the publication of regulations and supplements thereto. The regulations published to satisfy the majority of DoD directive requirements constitute the AFR-122 series. Additional guidance pertinent to this study is included in AFR 123-1, AFR 300-16, and Technical Order (TO) 00-110N-16.

AFR 122-1, and Supplements. The Air Force Nuclear Weapons Surety Program, as established by AFR 122-1, is the program through which the Air Force complies with the four Nuclear Weapons System Safety Standards outlined in DODD 3150.2. It is applicable to all Air Force units with a direct or indirect nuclear mission, while tasking Major Commands (MAJCOMs) and bases that host nuclear-capable tenants with support responsibilities. AFR 122-1 outlines the overall program and objectives by identifying the specific agencies, directives, and positions responsible for implementation. Of particular significance to this study are the responsibilities of the Air Force Logistics Command (AFLC) as identified in the regulation. Specifically, AFLC is tasked to comply with the procedures of AFR 122-3 "if the design, manufacturing, or modification effort affects nuclear certified equipment or procedures (12:9)." Additionally, AFLC must comply with AFR 122-2 if the effort affects the nuclear safety features or the critical function of the nuclear weapon system (12:10), as well as verifying compliance with the nuclear safety criteria in AFR 122-9 and AFR 122-10. AFLC is also tasked to comply with the data requirements of other DoD monitoring agencies, and satisfy the TO publication responsibilities noted in DODD 3150.2 (13:9).

Air Force Systems Command (AFSC) is identified as the focal point for the technical aspects of nuclear surety. In

particular, AFSC maintains the technology base for the development of nuclear safety design and evaluation criteria for publication in AFR 122-10 (12:10).

Supplements to the basic directives are essential to specify the particular agencies and branches responsible for the details of compliance with the regulation. The AFLC supplement to AFR 122-1 accomplishes this by specifying responsibility to ensure design and manufacturing compliance with the nuclear safety design criteria with the Directorates of Material Management at the appropriate center and within the appropriate program. AFSC supplements accomplish a similar result. Of particular note are the identification of positions such as the Nuclear Surety Officer and representatives to the Nuclear Weapons System Safety Group (NWSSG).

AFR 122-2, and Supplements. This Nuclear Weapon System Safety Studies, Safety Rules, and Operational Safety Reviews directive, was originally published to support DODD 3150.2 before it was superseded by DODD 3150.2. Nonetheless, the intent of the regulation remains unchanged, to set up controls and procedures to govern the conduct of safety studies and operational safety reviews and the development of safety rules for each nuclear weapon system (13:1). Specifically, AFR 122-2 establishes the USAF Nuclear Weapons System Safety Group (NWSSG) and designates its composition, as mentioned in AFR 122-1.

The NWSSG conducts all nuclear weapons systems safety studies and operational safety reviews for the Air Force and develops proposed nuclear weapon system safety rules [13:2].

The NWSSGs are not strictly a USAF entity, as the Army and Navy also convene them. Systems with any joint applications are coordinated between the services through the respective NWSSG.

In addition, AFR 122-2 clarifies the required safety studies, documentation requirements, and responsible agencies. Approval and coordination channels are defined for new rules or proposed changes. Finally, the regulation lays the foundation for the Nuclear Surety Inspection program, described later in AFR 123-1.

Of concern to this study, AFLC and AFSC have each supplemented the basic directive with designations of responsibilities and position appointments (NWSSG, etc.) particular to their respective functions.

AFR 122-3, and Supplements. The Air Force Nuclear Safety Certification Program, is the USAF implementation of DODD 4540.5, which requires establishment of a nuclear certification program for weapon systems and support equipment. AFR 122-3, is a key directive concerning this study.

A nuclear safety certification program is set up and maintained to make sure the design of US Air Force equipment and the procedures governing nuclear weapon system operations are evaluated against nuclear safety criteria and are nuclear safety certified before they are used with nuclear weapons [14:2].

Ultimately, the program is intended to prevent or greatly minimize the results of nuclear weapon accidents and/or incidents. To accomplish this, the program establishes requirements for equipment design certification, procedures certification, engineering evaluations, modifications, servicability standards, certified equipment lists, as well as addressing several other areas that do not have a bearing on this study (software, etc.) (14:3-5).

Equipment design certification requirements as identified in AFR 122-3 are essentially clarification on what types of equipment require certification, i.e. combat delivery vehicles, noncombat delivery vehicles, and moving/loading/storing support equipment. Equipment items used only in emergencies, handtools, common nonspecialized test equipment, etc., do not require certification. Design criteria for certified items are found in AFR 122-10 (14:14-17).

Procedures certification involves the publishing of IOs and changes to IOs to certified items. As noted in the synopsis of DODD 4540.5, the IOs are identified as the verification of procedures and modifications as being safe in relation to the Nuclear Weapon System Safety Standards (14:3).

Engineering evaluations are the application of AFR 122-10 criteria during acquisition, acceptance and testing.

Modifications, though covered by AFR 57-4 for procedure and policy, are evaluated against the certification criteria in the AFR 122 series, particularly AFR 122-10. Essentially, AFR 123-3 mentions the potential connection between modification and nuclear safety certification (14:4).

AFR 122-10, and Supplements. Safety Design and Evaluation Criteria for Nuclear Weapon Systems specifies the minimum criteria and standards that apply when developing, designing, or modifying a nuclear weapon system. It implements the requirements of DODD 4540.5. Reiterating the four Nuclear Weapon System Safety Standards, it goes one step further by specifying the minimum design criteria applicable to specific systems (aircraft, missile, etc.) as well as the noncombat delivery and support equipment for those systems. Of particular concern in this study are the criteria established for the latter.

The intent of the criteria in this section is to prevent damage to the nuclear weapon during handling and transportation. The safety design factors will allow for the uncertainties in predicting operational conditions (such as overloads, fatigue, wear, corrosion, residual stress, temperature influence on metal properties, and impact loads). The design factors will also allow for the uncertainties or variations in material strength and manufacturing techniques and the uncertainties introduced by simplified design and test procedures [15:15].

The criteria are intended to be based on, and supplemental to, good industrial standards and practices, and are not intended to prohibit the use of any commercially

designed nonspecialized equipment which meets the criteria (15:15). The criteria address ground transportation equipment; trailers and semitrailers; self-propelled ground vehicles; forklifts and weapon loaders; hoists, cranes, and similar devices; cargo aircraft systems; and, cargo restraints (15:14-17).

AFR 123-1, and Supplements. The Inspection System directive sets policies, procedures, and responsibilities for all USAF functions and activities that direct, conduct, or are subject to inspectors general inspections (16:1). Essentially the regulation creates a mechanism to measure readiness and effectiveness, while providing assistance and feedback to inspected units. Included in this directive (Chapter 2) are procedures for the conduct of Nuclear Surety Inspections (NSI) and the guidance needed by appropriate MAJCOMs and agencies.

The military importance and political sensitivity of operations with nuclear weapons dictate that all units and personnel maintain the highest possible standards of performance. The inspection system for nuclear weapons must be professional and thorough so that the nuclear capability of each unit is assured [16:20].

MAJCOMs and organizations responsible for conducting NSIs have supplemented the basic directive, specifically by development of checklists to insure a thorough analysis of nuclear activities particular to them.

TO 00-110N-16. Equipment Authorized for Use with Nuclear Weapons, a technical manual/order, is a derivative of DODD 4540.5 and clarifies exactly what equipment has been

approved for use with nuclear weapon systems. Since it prohibits the marking or similar identification of the vehicle's certification status, the TO serves as the sole source for verification. It also includes a section which identifies equipment which is specifically NOT nuclear certified to reduce confusion within stock classes, as the national stock number (NSN) is the formatting method used in the TO. TOs are not normally supplemented by other agencies.

Chanute Technical Training Center Materials.

Technical school training for USAF mechanics is conducted at the Chanute Technical Training Center (CTTC) at Chanute AFB, IL. All mechanics fielded by the USAF do not have to attend the school, and can earn a three skill level through On-the-Job (OJT). However, those that do attend CTTC receive both classroom and laboratory training in basic vehicle mechanic skills. The classroom training includes extensive use of handouts with schematic and written information (see Appendix A).

Career Development Course Materials. The Career Development Course (CDC) program is essentially a correspondence course program managed by the USAF Extension Course Institute (ECI) located at Maxwell AFB, AL. It supplements the OJT program by providing a classroom style exposure to written materials standardized within the Air Force training environment. Mechanics not afforded the

opportunity to attend in-residence training at CTTC, or those seeking upgrade to a skill level for which classroom training is not available, must complete the CDC program materials. Materials (see Appendix B) are provided by ECI and incorporated into a local training program managed by base and unit level training monitors.

#### Industry Standards

As noted in the synopsis of AFR 122-10, the criteria established for nuclear certification are intended to supplement good industry design standards, as well as accommodate variations due to manufacturing techniques. The DOT and NRC sanction the standards established by some organizations by publishing lists and ongoing study data in their publications (i.e. NRC's monthly Nuclear Safety magazine).

American National Standards Institute. The ANSI produces and coordinates development of standards that are recognized as acceptable by the NRC and DOT. The scope of the standards include:

Standards for activities and products which involve, utilize, or measure nuclear energy, ionizing radiation, fissionable or radioactive materials, and the processing and handling of nuclear materials. Excludes the application of radiation for medical purposes [2].

Many of the areas for which ANSI standards have been developed are continually under research, often as joint ventures between similar organizations. The ANSI also publishes lists of standards currently being researched (2).

American Nuclear Society. The ANS also develops standards that are recognized by the NRC and the DOT. "Standards are developed to the best current practices regarding various specific nuclear problems (1)." The ANS often works in conjunction with other organizations, including the ANSI (1).

#### Summary

This background reflects a progressive funneling of guidance from Federal agencies (DOT, NRC, etc.) drawing their authority from legislation, to specific users (DoD) who base their procedures and policies on the Federal guidance. The implications of this guidance can now be analyzed in relation to the certification and maintenance of noncombat delivery vehicles.

### III. Analysis

In light of the background provided in Chapter II, it is now possible to analyze the effect of Federal, DoD, and Air Force guidance on the purchase, employment, and maintenance policy categories for nuclear certified vehicles, as introduced in Chapter I.

#### Purchasing

Federal Guidance. As noted in Chapter II, the Federal guidance provided by the DOT through 49 CFR, and by the NRC through 10 CFR, each emphasize the concept of packaging (containers, placards, etc.) as the primary way to insure the transport of hazardous materials.

The physical distribution manager will find in reading the regulations that although hazardous materials containers and markings, etc., are clearly delineated, there are no standards for inspecting brakes, trailer hitches, rail car couplers and the like [3: 30].

The DOT, as the agency responsible for modal regulation (truck, rail, air and water), "... has overlooked the safety of the mode in the assumption that the safety of the packaging was all that mattered (3:30)." A review of 49 CFR reflects emphasis on containers that are intermodal and capable of withstanding accidents or damage of a severity that exceeds that normally expected to occur. The only "vehicular" type inspections that are identified are those for rail and motor tankcars/trailers. In each case the

criteria treat the "container" aspects of the vehicles (tank/valve/weld integrity, purging requirements, etc.) and do not address the chassis or functional parts of the unit. The shipment of DoD materials are not treated any differently as noted in Part 177.806, 49 CFR.

Shipments of hazardous materials offered by or consigned to the Department of Defense (DoD) of the U.S. Government must be packaged including limitations of weight, in accordance with the regulations in this subchapter or in containers of equal or greater strength and efficiency as required by DOT regulations [6:759].

Of course, this segment of 49 CFR is not intended to affect the strategic or tactical movement of weapons as required for national security, but it does reemphasize the DOT preoccupation with packaging.

The NRC, the regulatory agency responsible for container design and testing, reflects the same emphasis on packaging as the key safety element, even in regards to nuclear materials. "Primary reliance for safety in transport of radioactive material is placed on the packaging (32:4)."

The NRC has consistently played down the concern over routing, escort requirements, and mechanical failure by emphasizing the low risk of environmental damage. In WASH-1238, the NRC analyzed the risk associated with single motor vehicle transport versus convoy (carrying vehicles plus escorts), as well as the risk of collision or derailment for rail carriage versus mechanical failure. The

combined probability of incident per vehicle mile were less than one in a trillion (32:7).

The packaging criteria established by the NRC in 10 CFR are comprehensive. Classifications of package types (A,B, and C) are further supplemented with classes (I,II, and III) within the types. For example, fissile materials in Class I containers must be packaged such that any number of undamaged packages in a shipment (maximum of 250) would be subcritical in any arrangement when closely reflected on all sides by water (4:734). Fissile materials in Class II containers must be packaged in a shipment (maximum of 50) such that five times the allowable number of undamaged packages would be subcritical if stacked together and closely reflected on all sides by water (4:735). Fissile materials in Class III containers are even more restrictive.

Initial approval standards for containers and modification applications must be accompanied not only by a description of the container or modification, but also by a description of the quality assurance program required and test/evaluation data.

The effects on a package of the tests specified in Part 71.71 (Normal Conditions of Transport) and the tests specified in Part 71.73 (Hypothetical Accident Conditions) must be evaluated by subjecting a sample or scale model to test, or by other method of demonstration acceptable to the Commission, as appropriate for the particular feature being considered [4:731].

Of particular interest in this study are the lifting and tiedown standards for all packages. Part 71.45, 10 CFR

identifies the standards associated with packages, but as will be noted later in the analysis of US Air Force guidance on Purchasing, these same standards will appear to be applied to the lifting mechanisms (forklift, crane, etc.).

Any lifting attachment that is a structural part of a package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and must be designed so that failure of any lifting device under excessive load would not impair the ability of the package to meet other requirements of this subpart [4:732].

Similarly, tiedown devices (chains, straps, etc.) must be designed with a minimum safety standard of ten against yielding when used in the intended manner (4:732).

Comprehensive requirements for periodic inspection of containers are woven throughout 10 CFR. Some inspections include pressure testing of the container, some require X-raying, while others simply require a visual inspection (4).

In summarizing the Federal guidance as it pertains to the purchase of nuclear certified vehicles, it is essentially nonexistent in the form it would be used by the DoD. Extensive Federal emphasis on container design, modification, inspection, and usage standards are purposely intended to minimize or essentially ignore the impact of the mode on the transportation of hazardous materials, including fissile radioactive materials.

DoD Guidance. As noted in Chapter II, the DoD issued DODD 4540.5 and thereby introduced the concept of nuclear safety certification for both combat and noncombat delivery

vehicles. This concept is a manifestation of the DoD authority, as authorized by the DOT and NRC, to regulate those aspects of hazardous materials handling which are unique to its function (28:323). In view of the fact that nuclear weapons are operationally handled without the encumbrance of extensive packaging, certification of delivery vehicles would appear to accomplish the same function that DOT and NRC packaging emphasis does. The responsibility to implement nuclear safety certification for combat and noncombat delivery vehicles falls to the Secretary of each Military Department (8:3).

US Air Force Guidance. As noted in Chapter II, the Air Force has implemented Federal and DoD policy through a series of directives, particularly the 122 series of Air Force regulations. AFR 122-10 and its supplements reflect the specific requirements for certification of combat and noncombat delivery vehicles as compiled by the agency mandated to be the nuclear surety technical aspects focal point, AFSC.

In regards to noncombat delivery vehicles, the criteria established in AFR 122-10 cover some aspects common to the various vehicles it addresses. Analysis, examination, and testing of assets will be evaluated by the responsible Air Force agency to include operational testing of at least one fully configured article. Operational tests normally involve testing the first fully configured article to 110

percent of rated load, and the other articles to 100 percent, or testing the first fully configured article and selected samples to 110 percent of rated load. Structural analysis of the articles include insuring the weapon will be supported by the basic frame of the equipment rather than by lift arms, cables or hydraulic systems. Static grounding capability, fire retardation design, and prevention of transmission of mechanical shock to the weapon are also features to be analyzed (15:14-25).

Operational qualities of the vehicles are also reflected in AFR 122-10. For example, parking brake and slope ratios are identified for various vehicles. For example, trailer and semitrailer parking brake must be designed to hold a fully loaded trailer on a 11.5 degree incline with the trailer headed either up or down (15:15). Compatability between a towed trailer and the towing vehicle is addressed to insure sway, skid or jackknifing tendencies are not multiplied. Drift or drop limits of 0.5 inches per hour are design goals for materials handling/lifting equipment (15:14-25).

The detail of AFR 122-10 reflects a clear effort on the part of the Air Force to place emphasis on the mechanism of transportation versus the packaging, as emphasized by Federal guidance. However, as noted previously in this chapter under Federal Guidance, the safety margin of three to one (or ten to one for tiedowns) (15:14-25) continues to

be recognized as a goal whether it be associated with the packaging or the delivery vehicle.

In 1983, the three to one safety margin was reevaluated by Hq Air Force Weapons and Transportation divisions (Hq USAF/LEYW/LETN) as it related to purchasing noncombat delivery vehicles (26). Traditionally, the Air Force has purchased vehicles by determining the rated load capability desired and then buying assets of almost triple that capability to facilitate the three to one safety margin (24). On occasion this has impeded the ability of the asset to meet other requirements, such as the DoD criteria to engineer for transportability (5:13). For instance, the Air Force desired to purchase a seven and a half ton crane for use with nuclear munitions, which it ultimately rejected when it could not be validated at over 20 tons to meet the three to one safety margin. The manufacturer explained that in order to meet the three to one safety margin 30 percent more metal would be needed, which would place the crane at a weight that exceeded the capability of a C-130 cargo plane to tactically airlift it (25). Similar dilemmas over the cost of buying more capability than may really be needed, and the wisdom of restricting the load rating for all users at the expense of nonnuclear capability (26) caused Hq Air Force, in 1983, to solicit MAJCOM inputs concerning the three to one safety margin in purchasing.

Only AFLC and AFSC voiced concerns over any change to the criteria. Both were concerned that engineering goals relating to life expectancy and safety should not be subordinated to the benefits of cost savings and nonnuclear capability enhancement (22; 24).

Whenever the enforcement of the 3:1 safety factor is inconsistent with other desirable goals, such as cost effectiveness and logistics support, the reaction is to question the 3:1 safety factor as if it is unique to nuclear safety and is not required for nonnuclear applications. The 3:1 safety factor is neither unique nor original to nuclear safety [22:2].

AFLC and AFSC each believed that the goals of an acceptable safety margin and desired capability could be obtained by emphasis on acquisition procedures and specification corrections, versus modification to the safety margin criteria or separate nuclear/nonnuclear load ratings for equipment (22; 24). The three to one safety margin is also considered a "cushion" of safety in relation to the long usage life that Air Force vehicles tend to experience. The three to one margin can conceivably compensate for corrosion, metal fatigue or differences in maintenance that could effect an asset over its useful life or until remanufacture (24).

As a result of the input received from the MAJCOMs by Hq Air Force, the three to one safety margin was reemphasized as a requirement for handling of nuclear weapons, but not as a primary concern when purchasing equipment intended to meet both nuclear and nonnuclear

needs. Instead, the end user now bears the burden of insuring that the nuclear certified safety rating of the equipment meets the three to one criteria, versus the full capacity rating for nonnuclear usage, which now only requires a one and a half to one safety margin at time of purchase (26).

In summary, an analysis of Purchasing in relation to Federal, DoD, and Air Force policies depicts a Federal policy with reliance on packaging, and a DoD realignment of that emphasis with nuclear safety certification to accommodate safety in an environment with minimal packaging. Air Force implementation of nuclear safety certification is accomplished via specification of requirements for vehicles and evaluation standards, which may result in capacity/usage mismatches and a perceived reduction in the long term margin of safety.

#### Employment

Nuclear Surety Inspections. The evaluation of employment of nuclear safety certified equipment is a peripheral aspect of the Nuclear Surety Inspections as introduced in Chapter II under AFR 123-1. The teams, assembled and dispatched by MAJCOMs responsible for units with nuclear missions, utilize checklists that supplement the guidance of AFR 123-1. MAJCOMs are required to provide copies of those checklists to the Director of Nuclear Surety, AFISC/SNI (16:19). Typically, the teams have no

vehicle "expert" (transportation officer/NCO) assigned, nor are any checklists used that are dedicated to the noncombat support vehicles of which this study is concerned. Analysis of the checklists currently on file (current as of Dec 86) reveals a pattern of inspection in only two areas. First, all checklists address the usage of only nuclear certified equipment in relation to nuclear weapons handling. Second, the checklists allude to only a visual appraisal of the servicability of the vehicles used.

As noted in Chapter II, the use of uncertified equipment is, in itself, grounds for failure of a Nuclear Surety Inspection. NSI checklists referring to convoy procedures and aircraft on/offload all require a determination that only certified equipment was used. Hq SAC checklists also require an operator inspection of vehicles used to transport explosives. Operators are evaluated to determine if they checked for fluid leaks, ascertained if the brakes, electrical wiring, and steering were in good order, checked all locking pins (pintle hooks, etc.), and determined the certification of the vehicle for the purpose intended. Other MAJCOM checklists do not offer even as cursory an inspection as SAC.

The limited extent of the inspection in this area, however, is not surprising given the relative safety record of nuclear weapons transport/handling by noncombat delivery vehicle and the overall lack of emphasis placed on nuclear certification after purchase.

Air Force Nuclear Safety Incidents.

The United States has never had an inadvertent nuclear detonation, even a partial one, despite the severe stresses imposed on the weapons that might be involved in accidents [27:1].

Of the 32 nuclear weapons accidents experienced by the United States between 1950 and 1980, none were attributable to a noncombat delivery vehicle (27:9-16). The overall lack of an inadvertent detonation has been attributed to a host of engineering and design characteristics built into the weapons themselves, the combat delivery vehicles, and the two-man concept of operation. Noncombat delivery vehicle aspects have also been noted as contributing to the record.

Engineering, operational, and logistic studies and reviews of the complete weapon system and its intended environment from storage to target, resulting in weapons system safety rules that prescribe authorized procedures and impose limitations for operation of the nuclear weapon system; [and]

Reporting and Analysis of accidents, incidents, and deficiencies that involve the nuclear weapon system, support equipment, and procedures;

(27: 4-5)

Given the three to one safety margin employed on vehicles purchased during the period of 1950 to 1980, and the disproportionate exposure of combat delivery vehicles to accident potential during a period when airborne alert was utilized, it may be relatively inconclusive to project future noncombat delivery vehicle safety patterns based on the lack of accidents to date.

## Maintenance

As noted in Chapter I of this study, the Air Force Nuclear Safety Certification Program directive (AFR 122-3) specifically says that there are "no unique or separate nuclear safety maintenance standards." This absence of standards is echoed in TO 00-110N-16, Equipment Authorized for Use with Nuclear Weapons, by denying the use of recognition markings, stamps or similar mechanisms to facilitate any special maintenance effort. Finally, AFM 77-310, Volume II, Vehicle Maintenance Management, the functional guide for managing vehicle maintenance at the unit level, makes no reference whatsoever (to include non-inclusion of TO 00-110N-16 as a recommended item of technical data within a vehicle maintenance facility) to the existence of vehicle nuclear certification.

Training. Air Force vehicle mechanics receive training in one or all of three ways: in-residence training at CTTC, correspondence training via CDC, and OJT. Direct training on any aspect of nuclear safety certification for vehicles is not included.

A review of all materials provided students attending any course pertaining to vehicles that are nuclear certified (see Appendix A) revealed that no references are made during the course of training. This point was emphasized by a verbal comment from a CTTC instructor that "very few" vehicles were certified in the Air Force. In fact, the vast

majority of Air Force vehicle assets do meet nuclear certification criteria and are included in TO 00-110N-16 as being certified. A review of all CDC materials pertaining to vehicles that are nuclear certified (see Appendix B) revealed that no references are made during the course of training to the nuclear certification of vehicles. However, it is noteworthy that both CTTC and CDC training emphasize adherence to technical data which, according to DODD 3150.2 and subsequent Air Force guidance, is the final source of approved, nuclear safety certified procedures.

Technical Data. As noted previously, the technical data published by AFLC is the final source of approved, nuclear safety certified procedures relating to certified vehicles. However, the processing of that technical data and the relationship of that data to the original certification specifications is unclear. The certification criteria identified in AFR 122-10 does not necessarily find its way into the TO from which the asset will be maintained over the long run. For example, though self-propelled ground vehicles (trucks, vans, etc.) must have a parking brake capable of holding the vehicle with a rated load on an 11.5 degree incline with the vehicle facing up or down (15:16), test or retest of that capability is not required by the TO over the life of the vehicle. The only evaluation of that capability is a periodic visual evaluation of the overall brake system (17:2-18) or by

physically applying the park brake and then putting the vehicle in gear to see if it moves (20:7).

Similarly, though the goal for drift on a lifting vehicle is only 0.5 inches per hour (15:16), that criteria is not used during the maintenance lift test for certified or noncertified vehicles. In fact, lift tests are only required for cranes (not forklifts or platform lifts) when they have undergone "extensive repair or alteration." Even then, the only criteria is a limitation not to exceed 110 percent of the rated load at various radius and angle positions. The original certification drift goal is not retested (21:6).

The technical data does not appear to emphasize those aspects of a vehicles capability which were criteria for certification per AFR 122-10, as shown in the following quote from TO 36-1-23, Servicability Standards for USAF Vehicles:

The purpose of this technical order is to provide information to be used as a basis for determining minimum standards of USAF vehicles that must be met or surpassed before a vehicle can be declared servicable [20:1].

The standards subsequently established do not appear to be consistent with nuclear safety certification goals. For example, minor flaws in metal or plastic components are not normally considered to affect servicability, however no distinction is made in whether the flaws are in structural or body components. Welds that are used to attach items to

the vehicle "may be imperfect provided sufficient connecting metal remains to retain attachment through normal shipment, handling, and operation without further breaking or loss (20:3)." These visual criteria do not appear to reenforce the intent of the 122 series of regulations, particularly as they relate to capabilities to exceed rated load during testing or the safety margins desired.

Material Deficiency Reporting. Through IO 00-35D-54, USAF Material Deficiency Reporting and Investigating System, the Air Force has attempted to establish a mechanism to identify deficiencies in material (MDR), quality (QDR), and software (SDR). The IO establishes the classifications, the responsibility centers, the contact/action agencies, and the reporting/monitoring procedures. MDRs are classified as Class I and Class II, with Class I reflecting the highest consequences of deficiency: loss of life, damage to weapons, or severe impact on mission capability (13:2-1 - 2-2A). Nuclear safety deficiencies are further identified as Dull Sword Class I MDRs.

For the purposes of this study, concern emanates from the initiation of a vehicle MDR.

The originating point of the MDR (including QDR or SDR) is the discoverer of a design, maintenance, material, quality or software deficiency. Following discovery, the originating point must classify the deficiency as either a MDR, QDR or SDR ... [13:2-1].

This dependence on the base level mechanic or maintenance manager to identify and classify a deficiency

ignores the lack of nuclear certification training noted previously. Particularly in the absence of any nuclear certification references in the technical data, this dependence may be a responsibility the base level vehicle maintenance function is ill prepared to assume.

The Contact/Action Point responsibilities listed in the MDR TO include a requirement to:

... determine if the deficiency could be detected during normal maintenance; if so, is the appropriate inspection requirement established in the applicable technical order(s) [13:4-2A].

Again, the technical data notes the responsibility for discovery of potential MDRs as being placed at the lowest level.

Modifications. The vehicle mechanic will find references to vehicle modifications in both AFM 77-310, Volume II, Vehicle Maintenance Management, and AFR 57-4, Modification Program Approval and Management. However, the determination of what constitutes a modification could be affected by the awareness of nuclear certification criteria. "Adding special equipment to meet certain operational needs is not considered modification if the vehicle is still used for its original purpose (10:13-14)." However, "... a temporary installation of or change to, equipment to provide increased capability for a temporary special mission ..." is a modification and requires MAJCOM approval, contingent on AFLC concurrence (11:3). Many situations could fall into either example.

Additionally, MAJCOM and AFLC approval are only required on Air Logistics Center (ALC) controlled vehicles. Though the ALC controlled vehicles category does include many nuclear certified vehicles (463L MHE, M-Series Teactical Vehicles, munitions MHE), it does not include many other vehicles which are nuclear certified (lifts, trailers, trucks) (10:13-14).

It would appear that the modification program also relies heavily on a base level expertise not reenforced by training or technical data that openly emphasizes nuclear certification.

#### Summary

The analysis of Federal, DoD and Air Force guidance as each relates to nuclear certification of vehicles has revealed a Federal emphasis on packaging of hazardous materials that is paralleled by a DoD emphasis on vehicle certification. It has identified a Federal emphasis on container inspection that is not entirely paralleled by a DoD or Air Force emphasis on vehicle employment inspection. Lastly, it noted a Federal emphasis on container maintenance that is not directly paralleled by a USAF emphasis on training, technical data, or maintenance participation in procedures. Some conclusions and recommendations can be drawn from this analysis.

#### IV. Conclusions and Recommendations

##### Conclusions

The emphasis placed on certification of vehicles by the DoD would appear to be a reasonable alternative to the packaging approach of Federal guidance, given the operational constraints encountered when handling nuclear weapons. The lack of packaging has apparently been compensated for by concentrating on the mode. The good nuclear safety record enjoyed by the DoD (no inadvertent detonations attributable to noncombat delivery vehicles) is, to some extent, a reflection on the certification concept.

The relatively low level of inspection emphasis placed on the employment of nuclear certified vehicles is essentially a reflection of the overall low emphasis placed on the assets after purchase. The lack of a vehicle "expert" on the NSI teams is, again, an indicator of the determination at Hq Air Force that there is nothing to inspect. For example, the decision at Hq Air Force LEYW/LETN to modify the three to one concept over the recommendations of the engineers at AFLC and AFSC, seems to reflect a minimal regard for the long term certification of vehicles.

The lack of emphasis on training for vehicle mechanics places an added importance on the technical data activities of AFLC and essentially demands that every TO and

modification analysis be perfect, because there will be no in-the-field questioning of the action. Additionally, the lack of training places added emphasis on the mechanisms used to solicit Material Deficiency Reports and modification requests, because again there are no in-the-field experts able to knowledgably pursue MDR and modification goals as they relate to nuclear certification.

Invariably many modifications, accident repairs, and local contract maintenance actions on major vehicle components are being sanctioned by well meaning mechanics unaware of the certification criteria used to initially certify the vehicles. The lack of training forces AFLC and AFSC to be reactive, bearing the full burden of concern over long term certification of assets. This concern should be of particular concern in view of the perceived reduction in the three to one safety margin previously expected to offset the long term effects on certification.

#### Recommendations

The DoD emphasis on nuclear safety certification parallels Federal emphasis on packaging; however, the lack of DoD/Air Force emphasis on long term maintenance of nuclear certified vehicles does not parallel the Federal emphasis on long term maintenance of containers. Recommend that the Air Force:

Reappraise the need to provide knowledge of the nuclear certification of vehicles to vehicle mechanics during CDC, at CTTC, and during OJT.

Include a chapter in AFM 77-310, Volume II, Vehicle Maintenance Management, such that vehicle maintenance managers have knowledge of the nuclear certification program, and a responsibility to support its intent during unit level maintenance.

Expand the inspection of vehicle maintenance support of the long term certification status of assets, but only after training and management insight have been improved.

In addition, recommend that additional research be conducted to determine the parallel impact of maintenance on nuclear certified equipment that was not included in this study (i.e. bomb loaders, bomb trailers, etc.). Also, recommend research be conducted to compare the maintenance programs for nuclear certified noncombat delivery vehicles as performed by the other United States armed services.

Appendix A: Chanute Technical Training  
Center Material

Base Vehicle Equipment Mechanic (47230/47250)

Handouts

C4AST47250 034-HO-100	A/532H-19 Tactical Cargo Loader	8 Dec 86
C3ABR472XX 000-HO-201	Automotive Electrical Diagram & Schematic	4 Apr 86
C3ABR47230 001-HO-203	Diesel Engines (PTG Pump Flow)	4 Dec 86
CSABR47230 001-HO-403	Hydraulics	25 Feb 87
3ABR47230 HO-501A	Drive Axles	4 Nov 77
3ABR47230 HO-501B	Suspensions and Drive Lines	4 Nov 77
3ABR47230 HO-606	Steering, Clutches and Brakes	10 Sep 80
C3ABR47230 001-HO-701	Hydraulic, Electrical, Dispensing Systems	19 Dec 86
C3ABR47230 001-HO-805	A/S32-6 and 6a Schematics	26 Nov 86

Programed Text

4AST47250 5-PT-100	Maintenance of Diesel Engine Fuel Systems	17 Apr 80
C3ABR47230 PT-100	The Typical Fuel System	29 Apr 80
3ABR47230 PT-402	Hydraulic Brake System	27 Feb 79
3ABR47230 PT-404	Clutch Principles	29 Apr 80
3ABR47230 PT-501B	Springs and Shock Absorbers	9 Jun 78

Study Guides

C3AZR47250 SG-100	Diesel Engines	15 Nov 83
C3AZR47250 000-SG-100	Diesel Engines	29 Apr 87
C4AST47250 005-SG-100	Diesel Engines	29 Apr 87
C4AST47250 029-SW-100	25K Loader, A/S32H-5A Emerson Electric	6 Feb 87
C4AST47250 030-SW-100	40K Loader, (Space Corp)	5 Dec 86
C3ABR47230 001-SG-100	Automotive Engine Fundamentals	9 Jan 87

C3ABR47230 001-SG-200	Fundamentals of Automotive Electricity Engine Troubleshooting and Tune-up	11 Dec 86
C3ABR47230 SG-300	Diesel Engines	15 Nov 83
C3ABR47230 001-SG-400	Hydraulics, Air Systems, Brakes, Clutches, and Transmissions	5 Dec 86
C3ABR47230 001-SG-500	Power Trains, Steering and Truck Mounted Cranes	1 Dec 86
C3ABR47230 SG-600	Crawler and Wheeled Tractors, Graders and Power Control Units	12 Jan 82
C3ABR47230 000-SG-800	Materials Handling Forklifts	22 Apr 86
C3ABR47230 001-SW-803	40K Loader (Space Corp)	17 Nov 86

General Purpose Vehicle Mechanic (47232)

Handouts

C3ABR472XX 000-HO-202	Automotive Electrical	4 Apr 86
C3ABR47232 000-HO-204A	Diesel Engines (PTG Pump Flow)	4 Dec 86
C3ABR47232 000-HO-301B	Automotive Electrical Diagram and Schematic	22 Feb 85
C3ABR47232 000-HO-306	Niehoff Electronic Ignition Systems Service Guide	9 Oct 85
C3ABR47232 000-HO-401	Hydraulics	25 Feb 87

Programed Text

C3ABR47232 000-PT-301	Use of Test Equipment	15 Jul 86
3ABR47232 PT-606B	Springs and Shock Absorbers	9 Jun 76
3ABR47232 PT-607	Steering Factors	9 Mar 76

Study Guides

C3ABR47232 000-SG-100	Automotive Engine Fundamentals	9 Jan 87
C3ABR47232 SG-300	Diesel Engines	15 Nov 83
3ABR47232 SW-310	Air Brakes	13 Nov 79
C3ABR47232 000-SG-400	Hydraulics, Air Systems Brakes, Clutches, and Transmissions	5 Dec 86

Special Purpose Vehicle Mechanic (472X1X)

Handouts

C4AST47251D 037-HO-100	Hydraulic, Electrical, Dispensing Systems	19 Dec 86
C3ABR472XX 000-HO-201	Automotive Electrical Diagram and Schematic	4 Apr 86
C3ABR47231A/B HO-305	Diesel Engines (PTG Pump Flow)	4 Dec 86
C3ABR47231A/B HO-403	Hydraulics	25 Feb 87

Study Guides

C3ABR47231A/B SG-100	Automotive Engine Fundamentals	9 Jan 87
C3ABR47231 SG-300	Diesel Engines	15 Nov 83
C3ABR47231A/B SG-400	Hydraulics, Air Systems Brakes, Clutches, and Transmissions	5 Dec 86
C3ABR47231A/B SG-405	Power Trains, Steering, and Truck Mounted Cranes	1 Dec 86

Miscellaneous Materials (472XX)

Handouts

3340 TTG-HO-30-1	Materials Handling Equipment	15 Jan 80
C3AZR47000 000-HO-200N	Vehicle Management Report PCN N310032	4 Mar 85

Programmed Text

3340 TTG-PT-77-17	Power Takeoff	2 Apr 82
3340 TTG-PT-77-18	Drive Train Components	9 Nov 77
3340 TTG-PT-77-19	Conventional Steering Gears	12 Dec 79
3340 TTG-PT-77-24	Tools	18 Sep 79
3340 TTG-PT-80-1	Shop Safety	22 Nov 82
3340 TTG-PT-80-3	Technical Order System	22 Oct 80

NOTE: CTTC Materials that do not deal with nuclear safety certified vehicles (firefighting equipment, snow removal equipment, etc.) have not been included in this appendix.

Appendix B: Career Development  
Course Materials

Special Purpose Vehicle and Equipment Mechanic (47250/1)

Volume I, Vehicle Maintenance Management	Dec 81
Volume II, How Diesel and Gasoline Engines and Systems Works	Dec 81
Volume III, Power Trains, Hydraulic System, Chassis Units Front-End Alignment and Wheel Balancing, and Heating and Air Conditioning	Dec 81
Volume IV, Base Vehicle Equipment	Feb 82
Volume V, Forklifts and Loaders	Nov 81
Volume VI, Towing and Servicing Vehicles	Nov 81

General Purpose Vehicle Mechanic (47252)

Volume I, Vehicle Maintenance Management	Dec 81
Volume II, How Diesel and Gasoline Engines and Systems Works	Dec 81
Volume III, Power Trains, Hydraulic System, Chassis Units Front-End Alignment and Wheel Balancing, and Heating and Air Conditioning	Dec 81

Vehicle Body Mechanic (47253)

Volume I, Vehicle Maintenance Management	Dec 81
Volume II, Allied Trades	Jan 82

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ABSTRACT

The objective of this study was to analyze the amount of vehicle nuclear certification information available and to consolidate information pertinent to maintaining USAF vehicles under the guidelines of the Nuclear Weapons Surety Program into a single body of knowledge on which informed maintenance, policy, and inspection decisions could be made. The study examined Federal, DoD, and Air Force guidance as it pertained to the purchase, employment, and maintenance of noncombat delivery vehicles. Analysis of the guidance revealed the conceptual differences between Federal and DoD policy (emphasis on packaging versus emphasis on vehicle), and the comprehensiveness of the Air Force guidance at time of purchase versus the minimal employment and maintenance guidance to assure the long term certification of the vehicles. Recommendations included enhanced training for mechanics and increased involvement of maintenance management to facilitate assurance of the long term certification of vehicles. *Keywords:*

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