DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

NOV 29 2001

FROM: AFCESA/CES
139 Barnes Drive, Suite 1
Tyndall AFB, FL 32403-5319

SUBJECT: **Engineering Technical Letter (ETL) 01-20: Guidelines for Airfield Frangibility Zones**

1. Purpose. This ETL provides basic guidelines to all base civil engineers (BCE) and major command (MAJCOM) engineer staffs for the frangibility of all objects within the defined frangibility zone at all Air Force airbases and airfields. It was developed in response to a need to standardize the specific frangibility zone for all airfields, frangible design criteria, and material selection of all frangible objects within that zone. The frangibility of each object is identified with consideration to operational requirements and environmental restraints.

2. Application: All Air Force installations supporting flight operations.

2.1. Authority: Unified Facilities Criteria (UFC) 3-260-01, *Airfield and Heliport Planning and Design*.

2.2. Effective Date: Immediately.

2.3. Ultimate Recipients: BCEs and MAJCOM staff engineers.

2.4. Coordination: The provisions within this ETL were recommended by the Airfield Obstruction Reduction Initiative Tiger Team and coordinated with all MAJCOM/CE/DO/SE/SC offices during coordination of the revisions to AFMAN (I) 32-1123, *Airfield and Heliport Planning and Design* (now published as UFC 3-260-01, 1 November 2001).

3. References.

3.1. Air Force:

- Air Force Instruction (AFI) 32-1044, *Visual Air Navigation Systems*
- AFI 32-7063, *Air Installation Compatible Use Zone Program*
- Air Force Manual (AFMAN) 32-1076, *Design Standards for Visual Air Navigation Facilities*
- UFC 3-260-01, *Airfield and Heliport Planning and Design*
- ETL 01-1, *Reliability and Maintainability Design Checklist*

3.2. Federal Aviation Administration (FAA):

- FAA Advisory Circular (AC) 150/5345-45, *Lightweight Approach Light Structures*
- FAA AC 150/5345-44, *Specification for Taxiway and Runway Signs*
- FAA Specification E-2702, *Low-Impact Resistant Structures*
- FAA E-2604, *Low-Impact-Resistant Structures for Medium-Intensity Approach Lighting Systems*

3.3. Other U.S. Government References:

- Military Specification MIL-R-60346, *Roving, Glass, Fibrous*
- Federal Standard FED-STD-595, *Colors Used in Government Procurement*

3.4. Alabama Department of Transportation (ALDOT) 1205, IHS-710-4, Highway Department Design Bureau, *Uni-Directional and Multi-Directional Slip Base Connection for Sign Posts Type 4 and 5*

3.5. American Institute of Steel Construction (AISC):

- AISC *Manual of Steel Construction*
- AISC S303, *Code of Standard Practice for Steel Buildings and Bridges*

3.6. Other Private Industry References:

- International Civil Aviation Organization (ICAO) Document 9157, *Aerodrome Design Manual*
- *International Journal of Crashworthiness*, Woodhead Publishing Limited, Cambridge, England, 1999, Volume 4 Number 1, *Analysis and Evaluation of a Redesigned 3" x 3" Slipbase Sign Support System Using Finite Element Simulations,* D Marzougui, A Eskandarian and L Meczkowski
- American Society of State Highway and Transportation Officials-Associated General Contractors-American Road and Transportation Builders Association (AASHTO-AGC-ARTBA) Joint Committee, Task Force 13 Report: *A Guide to Small Sign Support Hardware*, June 1998
- American Aluminum Association, *Engineering Data for Aluminum Structures*
- American Society of Testing and Materials (ASTM) A 36/A 36M, *Standard Specification for Carbon Structural Steel*

4. Acronyms and Terms:

AISC - American Institute of Steel Construction
ALS - approach lighting system
ASTM - American Society of Testing and Materials
BCE - base civil engineer
ETL - Engineering Technical Letter
FAA - Federal Aviation Administration
FAM - frangible approach mast
FHA - Federal Highway Administration
GRP - glass-reinforced plastic

ICAO	- International Civil Aviation Organization
ILS	- instrument landing system
LIR	- low-impact-resistant
MAJCOM	- major command
MG	- mounted on ground
MLS	- microwave landing system
NTE	- not to exceed
RDM	- runway distance marker
TACAN	- tactical air navigation

5. Structural Requirements and Frangibility Criteria.

5.1. Definitions.

5.1.1. *Airfield Obstacles* - All fixed objects located within the airfield environment that extend above any of the imaginary surfaces of the airfield or are located within the mandatory zone of frangibility. Airfield obstacles may be of either standard or nonstandard design. Obstructions are also classified as obstacles.

5.1.2. *Frangibility* - The ability of an object to collapse or fall over when struck by a moving aircraft such as to cause minimal damage to the aircraft, not impede the motion of the aircraft, or radically alter the path of the aircraft.

5.1.3. *Frangible Device* - A device which has been designed, configured, and fabricated in such a way that it is very sensitive to time-dependent dynamic impact, but immune to the normal environmental and operational loads imposed on the device during the lifetime of the structure.

5.1.4. *Frangible Object* - An object of low mass designed to break, distort, or yield on impact to present a minimal hazard to the aircraft.

5.1.5. *Frangible Support* - A support for elevated fixtures or other devices composed of a supporting element with a fracture mechanism at its base. It is designed to present a minimum of mass, and to break at the base when impacted. It is used when the mounting height is 2 meters (6 feet) or less above the mounting surface.

5.1.6. *Impact Energy* - The energy required for an object to break, distort, or yield when subjected to an impact load.

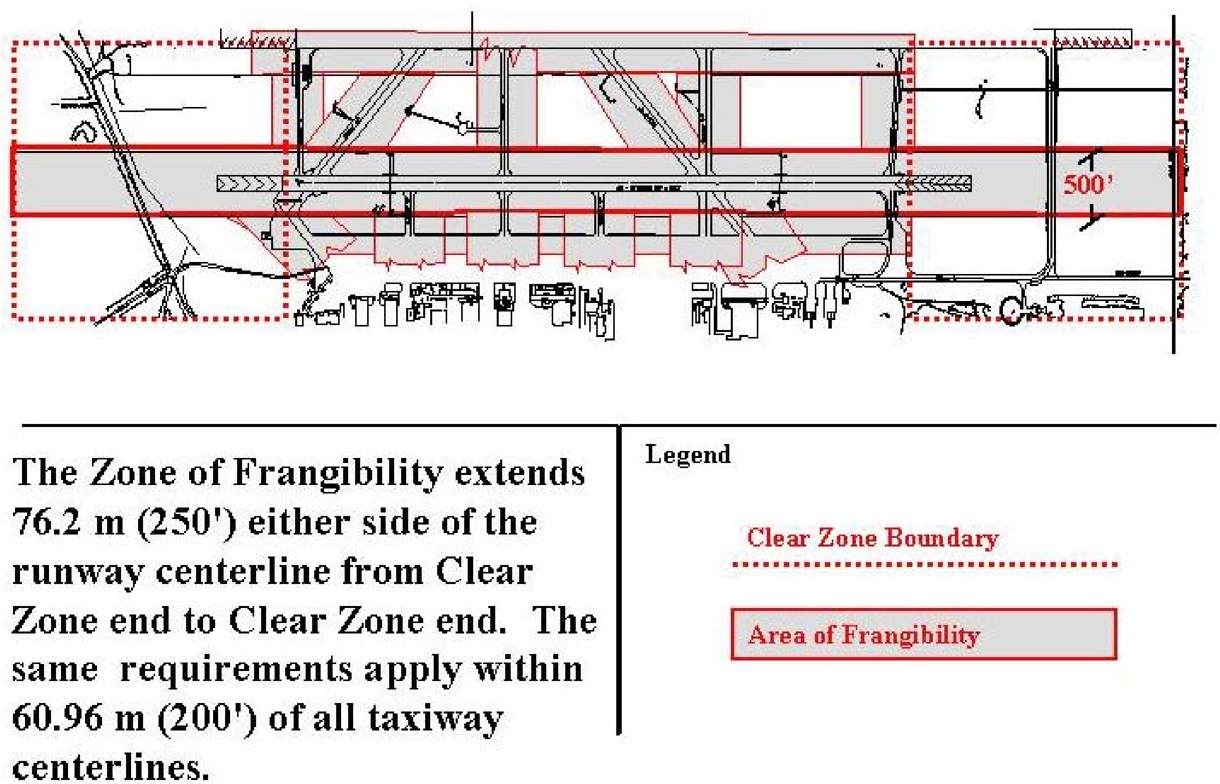
5.1.7. *Impact Load* - A sudden application of a short duration dynamic load or force.

5.1.8. *Low-Impact-Resistant (LIR) Support* - A support for elevated fixtures or other devices designed to present a minimum of mass, and to break with minimal resistance when impacted. It is used for supporting structures between 2 and 12 meters (6 and 40 feet) above the mounting surface.

5.1.9. *Semi-Frangible Support* - A two-element support for light fixtures or other devices designed for use in applications where the mounting height is over 12 meters above the ground, or the facility or device is constructed over a body of water. These supports are comprised of a rigid base or foundation with a frangible or LIR support used for the upper portion of the structure. The rigid portion of the structure must be no higher than required to allow performance and maintenance of the apparatus and the frangible or LIR support.

5.2. *Frangibility Zone* - For all Air Force airbases, the zone of frangibility consists of all areas within 76 meters (250 feet) of the runway centerline along its entire length out to a distance of 914 meters (3000 feet) beyond the runway threshold, or to the base boundary. This zone of frangibility also includes a 61-meter (200-foot) lateral distance from all taxiway centerlines for the entire length as shown in figure 1.

Figure 1. Diagram of Frangibility Zone.



5.3. Environmental Loading Conditions. Although required to be frangible in design, structures must be capable of withstanding the environmental conditions to which they will be exposed during normal service. Design of a frangible device or structure must, at a minimum, consider the following loads:

5.3.1. Wind Loading. The structure must be sufficiently strong and rigid enough to meet the operational requirements of normal service at a minimum wind speed of 112 kilometers per hour (70 miles per hour). In addition, the structure should be capable of surviving at higher wind speeds. This structural survival wind speed is based on the conditions at the airfield's geographical location. In designing for structural survival, the wind loading should be based upon historical wind data for that location or local design code requirements.

5.3.2. Jet Blast. The loading from engine jet blast must not cause the frangible structure to fail or receive permanent deformation. The exhaust contours of a DC-10 aircraft are currently accepted as the most severe conditions. Actual design loading for a particular structure is dependent on the distance and orientation of the structure from the aircraft.

5.3.3. Vibration. The components of the frangible structure must be designed such that no member or combination of members will vibrate under environmental loading at or close to the resonate frequency.

5.4. Frangibility Requirements. All structures within the frangibility zone must be frangible or a MAJCOM-approved waiver is required in accordance with UFC 3-260-01, *Airfield and Heliport Planning and Design*. Structural system frangibility must consider the worst case for frangibility in all applicable directions and be verified through an approved test or analysis procedure if the structure is not already approved as frangible. This test or analysis procedure must clearly demonstrate that the candidate system meets all of the frangibility criteria of this ETL. While waivers may be used for essential structures that cannot be made frangible and for temporary purposes, analysis and test methods must ultimately be used. Guidelines for the analysis and testing of frangible structures are provided in paragraph 5.6. Final acceptance of new frangible system designs must be based upon thoroughly documented analysis and/or test results.

5.5. Acceptance Criteria for Frangibility. In general, the object is considered frangible if it breaks, deforms, or yields readily upon impact and it is judged that the resulting damage to the impacter is such that no hazardous condition exists. The specific acceptance criteria to ensure that these objectives are met are as follows:

5.5.1. Values of Energy and Peak Force. Upon sudden impact (approximately zero rise time), the structural system must be designed to fail at a peak force of no higher then 2275 kilograms (5000 pounds) acting for approximately 0.008 second (8 milliseconds) and absorbing not more than 949 joules (700 foot-pounds) of energy. These criteria were adopted from International Civil Aviation Organization (ICAO) Document 9157, *Aerodrome Design Manual,* and based upon the minimum amount of impact and energy required to affect the flight stability and structural integrity of a Piper Aztec aircraft having a mass of 3000 kilograms (6600 pounds) and traveling at 50 kilometers per hour (27 knots) while taxiing, or 140 kilometers per hour (75 knots) during flight. In addition, the maximum allowable drop in velocity for the design aircraft in flight is 4 kilometers per hour (2 knots).

5.5.2. Determination of Acceptance. Paragraph 5.5.1 provides specific values of energy and peak force for use as acceptance criteria. Determination of acceptance may be based on visual inspection and interpretation. This is the result of variation in the construction of airfield systems and their support structures.

5.5.2.1. The impacted object should give way to the passage of the aircraft in such a manner that the aircraft may still achieve a successful landing or continue the take-off procedure; thus, the portion of the object above the point of impact should not grasp the aircraft wing while the lower portion remains attached to the foundation, inordinately altering the direction of the aircraft. Objects that "wrap around" the wing of the aircraft do not necessarily present a hazard if there is segmentation or the bottom portion releases from the foundation and the object is carried by the aircraft. The response of the object to impact is affected not only by the structure, but also by other components that are part of the installation. In the case of cabling, there should be points of disconnection so that structural segmentation is not hindered.

5.5.2.2. Upon impact, the frangible system may fragment into several components. The mass of these components and their manner of release should not cause a secondary hazard to the aircraft (e.g., penetrate the windscreen).

5.5.2.3. In the case of objects that would be impacted by aircraft on the ground, a greater amount of damage to the aircraft is considered acceptable than would be allowed for objects that would be impacted by airborne aircraft. Since the aircraft is already on the ground, the primary objective is to avoid injury or loss of life.

5.6. Analysis and Testing of Frangible Designs.

5.6.1. General Considerations. This section provides general requirements for the analysis and testing of a structure to determine its compliance with the frangibility requirements criteria of paragraphs 5.4 and 5.5. Since actual impact of the structure with the design aircraft is not practical from the economic or safety standpoint, the tests and analyses should be designed to verify only the quantitative acceptance criteria set forth in paragraph 5.5. However, the final presentation of results for approval should also qualitatively address the additional criteria of paragraph 5.5 and non-conformance with any of these criteria may form the basis for rejection of the design. From the economic standpoint, all acceptance criteria could ideally be verified through dynamic analyses only. This should be possible for simple structural types where failure modes and dynamic responses are already clearly understood. However, complex structures or structural systems may also require limited dynamic testing to first understand their behavior. These limited test results can be used to calibrate and/or validate more complete analytical results that encompass the full range of possible impact conditions. For each structure, the basis for choice of analytical modeling approach and the use or non-use of supplemental testing must be clearly documented for review and acceptance by HQ AFCESA.

5.6.2. Frangibility Analyses.

5.6.2.1. General. The impact of a moving airplane upon a stationary structure is clearly a dynamic problem. Therefore, dynamic analyses are required to fully understand the forces and transfer of momentum involved. Conventional static analyses are required in the early stages of design of the structure to verify its strength against conventional environmental and self-weight loadings, but dynamic analyses will be required to verify the frangibility of the structure to aircraft loadings.

5.6.2.2. Applied Loads. Loadings should be applied in a manner consistent with standard practice and must correctly represent the design aircraft impact. Locations for application must be chosen to represent the worst case for frangibility in all applicable directions.

5.6.2.3. Dynamic Analyses. The required complexity of the dynamic analyses will vary depending upon the complexity of the structure under consideration. For example, structures with simple mass distributions and support conditions, such as a cantilevered signpost, may be studied easily and effectively by a conventional single- or multiple-degree-of-freedom analysis. More complex structures should be studied through dynamic finite element analyses.

5.6.2.3.1. For simplified analyses, provide careful documentation of the conversion of the structure to a single- or multiple-degree-of-freedom system, development of static resistance functions, and time step choices. Full graphical results of the step-by-step analysis should be provided.

5.6.2.3.2. For finite element analyses, a general purpose code that is well suited for non-linear dynamic analyses should be used. Choice of element types, dimensions, material properties, and methods of loading must be well documented and in accordance with standard practice for finite element analyses.

5.6.3. Frangibility Testing.

5.6.3.1. General. High-impact short-duration dynamic tests are required to induce failure and determine the dynamic response of the structure. A pendulum test is a relatively economical means for this purpose. Conventional ram-type loaders may not provide adequate displacement magnitude to carry the structure through its full response, and the maximum loading rate available will not induce a dynamic response in the structure.

5.6.3.2. Impacter. Ideally, the impacter would have a mass of 3000 kilograms and a maximum velocity of 140 kilometers per hour as defined in paragraph 5.5 for the aircraft of reference. However, the test setup for this will generally be prohibitively expensive. Impacters of lower mass and less velocity are acceptable and the test results should be used to validate/calibrate analytical models that consider the actual required mass and velocities. The impacter must still impart enough force/energy to carry the structure through its complete range of motion and induce failure. Thus, impacter requirements will vary from structure-to-structure. The choice of impact location(s) for each test will be based upon at least two primary criteria: impacts should be at the most probable impact locations from an actual aircraft; and at locations most beneficial to validation/calibration of the analytical model.

5.6.3.3. Data Collection. The primary objectives of data collection are to thoroughly document the test configuration and the response/failure modes of the structure, and to capture enough time- or displacement-dependent data for use in the validation/calibration of the analytical model. Actual data collection requirements will vary significantly for each structure, but minimum requirements for each test are as follows:

5.6.3.3.1. Still Photography. Color (digital or analog) photographs should be used to thoroughly document the overall pre-test configuration and all post-test results. Conventional (normal-speed) video may also be used as a supplement, but not as a replacement for this purpose.

5.6.3.3.2. High-Speed Photography. High-speed photography (digital or analog) should be used to capture the dynamic test and resulting structural response. The required minimum frame rate of the test will vary, depending upon the expected rate of loading and structural response. In general, the frame rate should be a minimum of 1000 frames per second based upon the requirement for frangible structures to fail within 8 milliseconds under the design loading. The resulting photographs must allow for calculations of time-varying velocities of both the impacter and structure for use in determining the residual velocity of the impacter.

5.6.3.3.3. Applied Load. The dynamic load applied to the structure should be digitally recorded as a function of time and/or displacement. Sampling rates may vary, but must always be of sufficient rate to fully capture all significant changes in load. In general, the minimum sampling rate should be one sample per millisecond or less due to the short duration of the loading and the short time required to failure.

5.6.3.3.4. Structural Displacement(s). The dynamic displacement(s) of key components of the structure should be digitally recorded as a function of time and/or load. Sampling rates may vary, but must always be of sufficient rate to fully capture all significant changes in load. In general, the minimum sampling rate should be one sample per millisecond or less.

5.6.3.3.5. Strains. Requirements for strain gauges will be highly varied depending upon the structure, but strains at locations of expected maximum elongation within the structure should be captured as the minimum to allow for comparisons to analytical results.

5.7. Material Selection for Objects in the Frangibility Zone.

5.7.1. General.

5.7.1.1. The energy required to activate failure or the break-away mechanisms depends on the efficiency of the mechanism's design and on the number of mechanisms to be activated. The energy absorbed through plastic or elastic deformation of the structure is strongly dependent on the choice of material. The amount of energy absorbed will be higher for ductile materials with high-yield strains. Brittle materials are more desirable in most cases.

5.7.1.2. The kinetic energy required to accelerate the obstacle/object, or part of it, is dependent on the aircraft velocity and the mass to be accelerated. The mass of the structure should therefore be limited through the incorporation of lightweight materials and suitably located failure or break-away mechanisms within the structure.

5.7.1.3. The structural damage to the aircraft is also related to the contact area between aircraft and obstacle. This contact area should not be so small that it concentrates the loading, thus causing the obstacle to cut deep into the aircraft's structure.

5.7.1.4. Some aircraft have fuel tanks located before the spar. Although the loss of fuel upon rupture of the fuel tanks is not necessarily a life-threatening hazard, the possibility of such occurrence is further justification to use non-ferrous materials for object construction whenever possible.

5.7.2. Structural Frames. The materials and configuration for structural frames, mechanical equipment, and support mechanisms in the frangibility zone must be suitable for their intended use, while attempting to achieve the lightest structure possible. Energy absorption is proportional to the area under the load deflection curve, which for a frangible component is approximately that of the stress-strain curve of the material in tension. High-modulus, low-density brittle materials such as composites, ceramics, and fiberglass are preferable over ductile materials such as steel.

5.7.3. Aluminum. All aluminum parts, except for aluminum castings, will be manufactured of alloy 6061-T6511, as specified by the American Aluminum Association, *Engineering Data for Aluminum Structures*. All aluminum castings will be of aluminum alloy A356-T6.

5.7.4. Aluminum Hardware. Aluminum bolts, nuts, and washers will be manufactured from alloy 2024-T4, as specified in *Engineering Data for Aluminum Structures*.

5.7.5. Structural Steel Plates and Angles. All steel plates and angles must be American Society of Testing and Materials (ASTM) A 36/A 36M, *Standard Specification for Carbon Structural Steel*. All structural steel work must comply with American Institute of Steel Construction (AISC) *Manual of Steel Construction*, Chapter M, and AISC S303, *Code of Standard Practice for Steel Buildings and Bridges*.

5.7.6. Glass-Reinforced Plastics (GRP). The materials for GRP structural components, where not specified in the contract documents, must be suitable for the service conditions specified in paragraph 5.5. The GRP structural components must achieve the physical properties specified in the contract documents. Molded or plat plates must have glass cloth fiber reinforcing. For the filament-wound tubes, the glass reinforcement must be in accordance with Military Specification MIL-R-60346, *Roving, Glass, Fibrous*, Type I. All GRP members, except where specifically indicated or otherwise in the drawings, must be light absorbent (Cyasorb® UV 9 light absorber or equivalent), and orange in color. Color 12197, in accordance with Federal Standard FED-STD-595, *Colors Used in Government Procurement*, must be incorporated into the resin in accordance with the manufacturer's instructions.

5.8. Electrical Components Frangibility. Electrical equipment/components and their support system must be designed to be frangible while ensuring that their operational functions are not degraded. When feasible, it is recommended that electronic equipment be positioned below ground level. Prevention of fire hazards that are the result of conductor arcing must be considered part of a successful frangible design.

5.9. Foundation. Firm foundation bases are essential for a precision visual or non-visual navigation aid. The design of the base should provide maximum stability. Navigational aids are commonly supported on a concrete base which should not be allowed to be an obstacle to aircraft overrunning an airstrip or taxiway. This objective can be achieved either by depressing the foundation base below ground level or by sloping its sides so that the aircraft will ride over the base. Where the base is depressed, the cavity above the base should be back-filled with appropriate material. This, together with the frangible construction of the navigational aid and its supports, ensures that no substantial damage would be sustained by the aircraft.

5.10. Maintenance.

5.10.1. Periodic maintenance of frangible supports should be considered part of the selection criteria. As a result, there may well be an increase in initial cost to purchase suitable equipment. It is important to remember that the frangible structure will no longer meet frangibility requirements if the structure itself is used as a climbing frame or altered through the addition of a fixed ladder. The total structure should thereby be maintained by either using equipment that can easily be moved into position or by lowering the structure to the ground.

5.10.2. Frangible structures can be manufactured so that they can be mechanically lowered from a hinge point. In some instances, normal scaffolding may be used. The erection and dismantling of scaffolding, however, will considerably extend the time during which the structure would be temporarily infrangible.

6. Operational Guidance.

6.1. Siting of Objects in the Frangibility Zone.

6.1.1. The first objective must always be to site objects at an airfield so they are not obstacles; whenever feasible, objects must be sited outside the frangibility zone.

6.1.2. When an object must be sited in the frangibility zone, then the object and all of its support structure must be of minimum mass and designed to be frangible to assure that impact will not result in loss of control of the aircraft. In general, objects and fencing should be sited as far away from the runway and taxiway centerlines as practicable.

6.1.3. In cases where frangible design of equipment is impractical or jeopardizes operational performance, the equipment should be positioned so as not to present a hazard to the aircraft. For example, the instrument landing system (ILS) localizer equipment may be segmented so that only the frangible antenna is on the extended runway centerline and the transmitter housing is located to one side of the centerline, beyond the mandatory area of frangibility.

6.2. Frangible Objects. The following objects will be made frangible:

- Elevated runway, taxiway, and stop-way lights
- Approach lighting systems
- Visual approach slope indicator systems
- Airfield signs and markers
- Wind direction indicators
- ILS localizers
- ILS glide path
- MLS (microwave landing system) approach azimuth equipment
- MLS approach elevation equipment
- Radar reflectors
- Anemometers
- Ceilometers
- Transmissometers
- Security fencing
- Vehicle control signs and traffic lights

6.3. Operational Requirements. It is expected that a frangible structure will deflect when exposed to environmental loads, but it is important that this structural deflection not affect the signal quality of the navigational aid the structure supports. The following deflection tolerances must be maintained with respect to the navigational aid that is supported:

6.3.1. Approach Light Systems. Environmental loading should not cause the structure to deflect such that the light beam exceeds 2 degrees of deflection in the vertical axis and 5 degrees of deflection in the horizontal axis.

6.3.2. Wind Direction Indicators. No special deflection tolerances are required.

6.3.3. ILS Localizer. Environmental deflection tolerances for this structure must meet applicable system monitoring limits for the particular installation and facility performance category of operation.

6.3.4. ILS Glide Path. Environmental deflection tolerances for this structure must meet applicable system monitoring limits for the particular installation and facility performance category of operation.

6.3.5. MLS. Environmental deflection tolerances for this structure must meet applicable permissible operating tolerances for beam accuracy.

6.3.6. Anemometers. This equipment usually consists of a wind-speed sensor and a direction sensor that are both located on the same mast. The mast should be subject to the minimum vertical deflection that ensures the sensors are always in equilibrium. For the wind speed sensor, the response time must not be adversely affected. For the direction sensor, deflection must ensure that the wind vane does not have a preferred null position, and has a single equilibrium position with respect to each wind direction.

6.3.7. Ceilometers. Environmental deflection tolerances for this structure must meet applicable system accuracy.

6.3.8. Transmissometers. Environmental deflection tolerances for this structure must not effect the precise alignment of the transmitter and receiver nor compromise measurements.

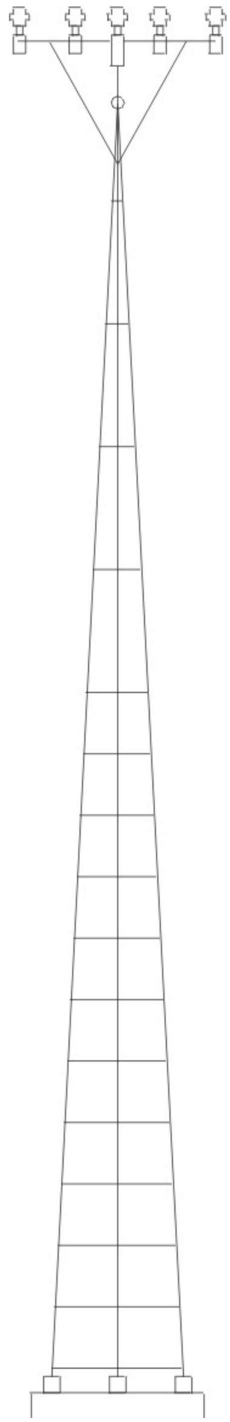
7. Approved Frangible Designs.

7.1. Frangibility of Visual Aids, Fixtures, and Mounting Devices. To minimize the hazard to aircraft, approach lights should have a frangible device at their base, or their structural support system should be of a frangible material design. In all cases, the unit and support system of the approach lighting system (ALS) should fail when an impact load of not more than 5 kilograms (11 pounds) and a static load of not less than 230 kilograms (500 pounds) are applied horizontally at 300 millimeters (12 inches) above the structure's break point.

7.2. Frangible Approach Mast (FAM). The FAM is designed to collapse on impact by an aircraft, with minimal damage to the aircraft. The FAM is constructed using principles of friction. When assembled correctly, the FAM will withstand wind loads of 160 kilometers per hour (100 miles per hour), or 120 kilometers per hour (75 miles per hour) with an ice coating of 12 millimeters (0.5 inch). See Figure 2 for the FAM approved under the Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5345-45, *Lightweight Approach Light Structures*, and FAA E-2604, *Low-Impact-Resistant Structures for Medium-Intensity Approach Lighting Systems*.

Note: The structures shown in Figures 2 (FAM), 3 (MG-20), and 4 (MG-30/40), are manufactured by Jaquith Industries, Inc., 600 E. Brighton Ave., Syracuse, New York, 13210, telephone: (315) 478-5700, fax: (315) 478-5707, Internet: www.jaquith.com.

Figure 2. FAM.



7.3. LIR Structures. LIR structures are used to support the lights of approach lighting systems or other equipment in a fixed alignment and orientation. Since the height of the support structure required for each ALS varies for each light station, three different types of LIR are provided, which can be tailored in the field to a specific height. These three types of LIR structures are designated as MG-20, MG-30, and MG-40. "MG" stands for "mounted on ground," and the numbers 20, 30, and 40 indicate the approximate maximum height of the structure in feet (see Figures 3 and 4).

Figure 3. MG-20 LIR Structure.

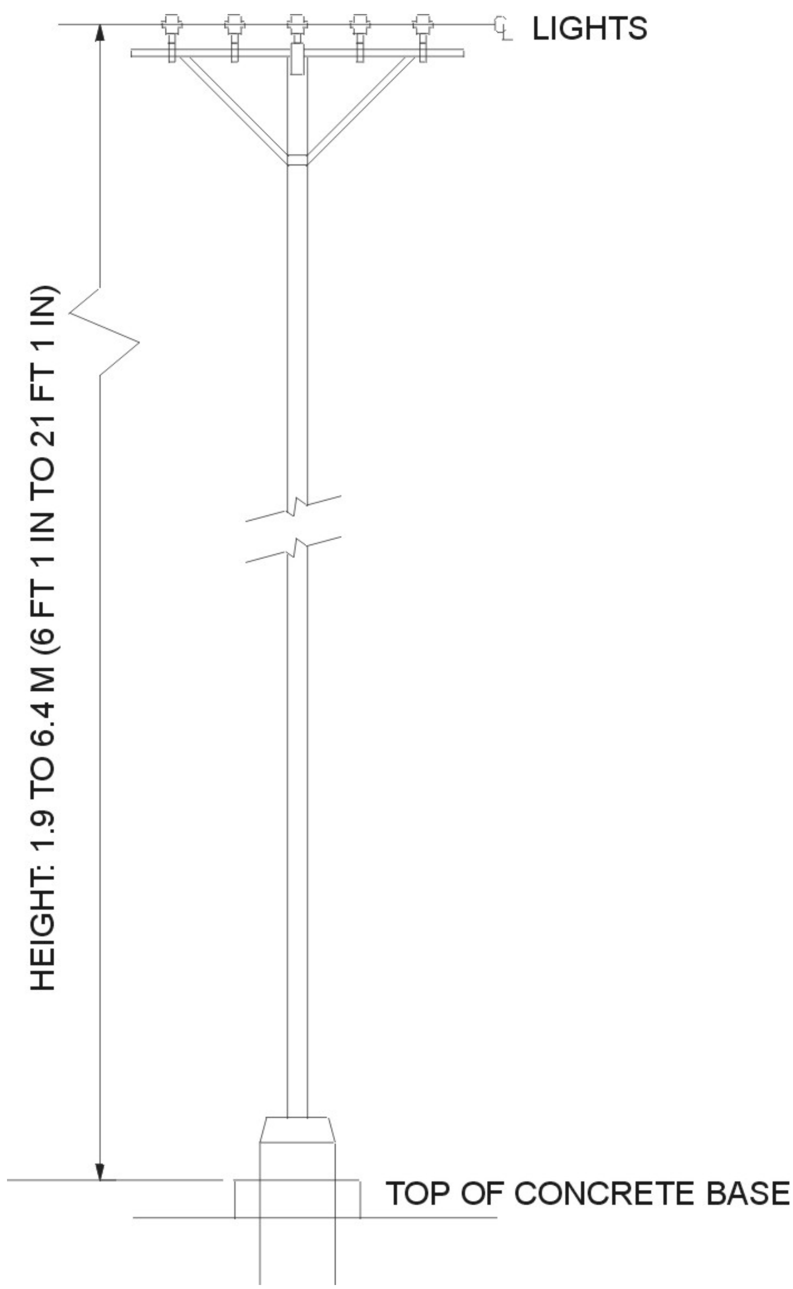
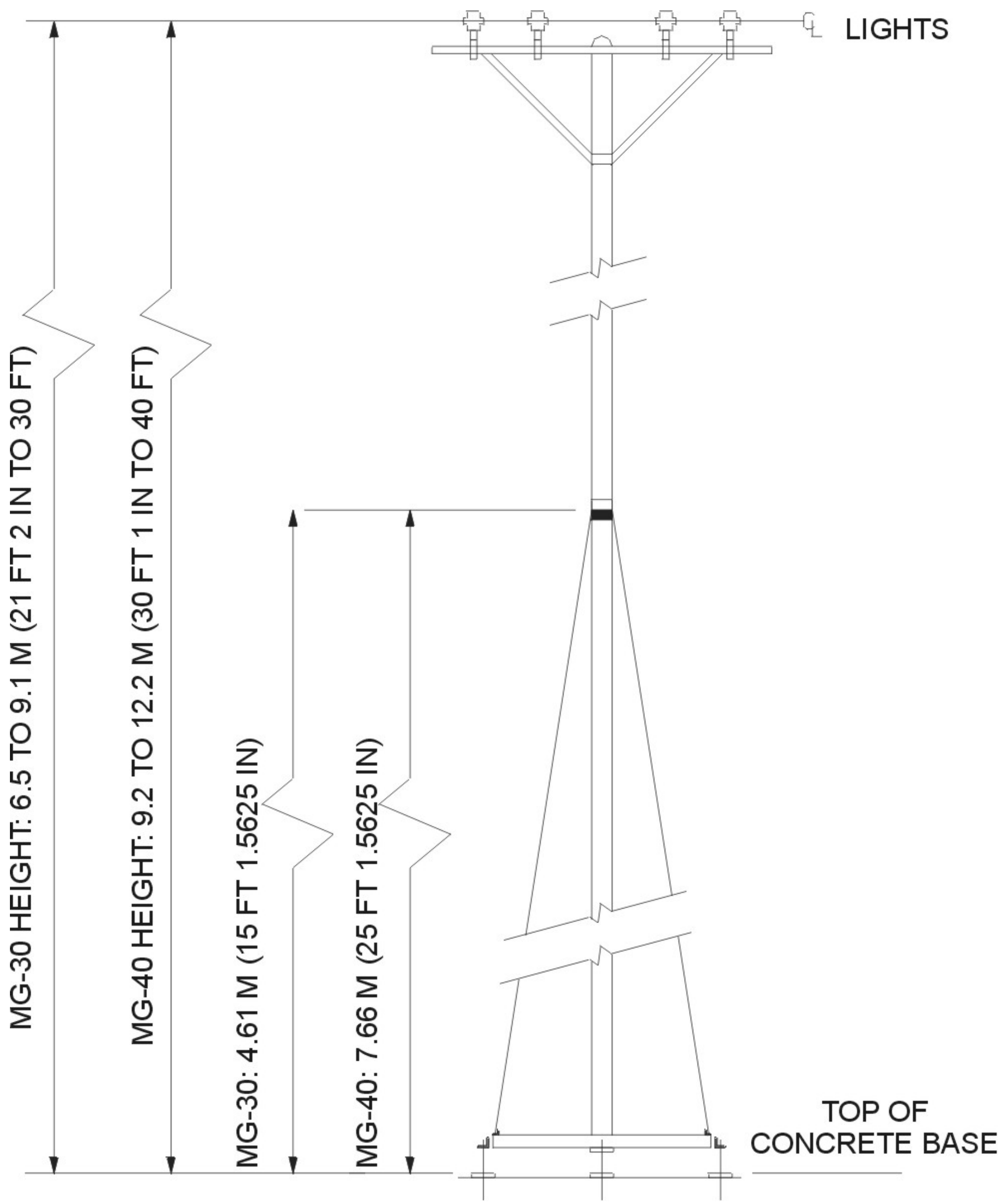
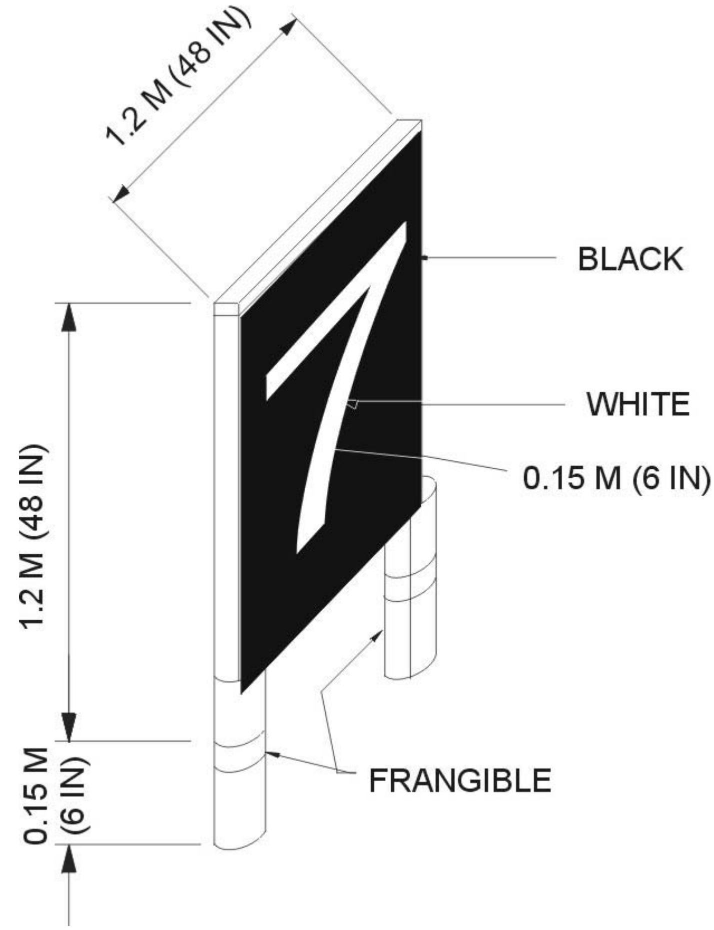


Figure 4. MG-30/40 LIR Structure.



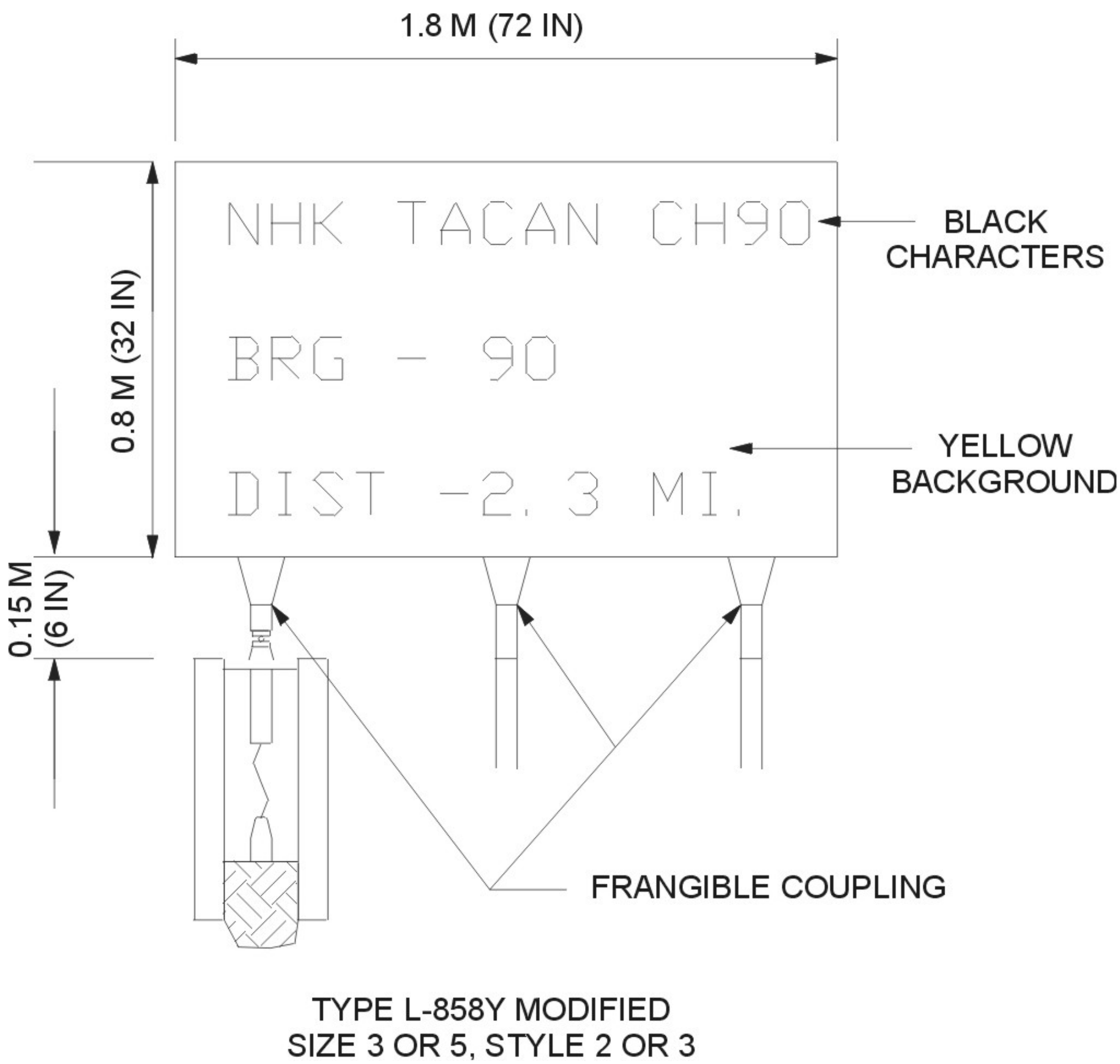
7.4. Runway Distance Marker (RDM). RDMs must be readable from a minimum distance of 150 meters (500 feet) under meteorological visibility conditions of 900 meters (3000 feet), by day or night. When ordering, specify structures that meet the requirements of FAA specification AC 150/5345-44, *Specification for Taxiway and Runway Signs*. These signs include a frangible device at the base. See Figure 5 for a Type L-858-B marker, size 4 [style 4 unlighted, style 3 illuminated]).

Figure 5. RDM.



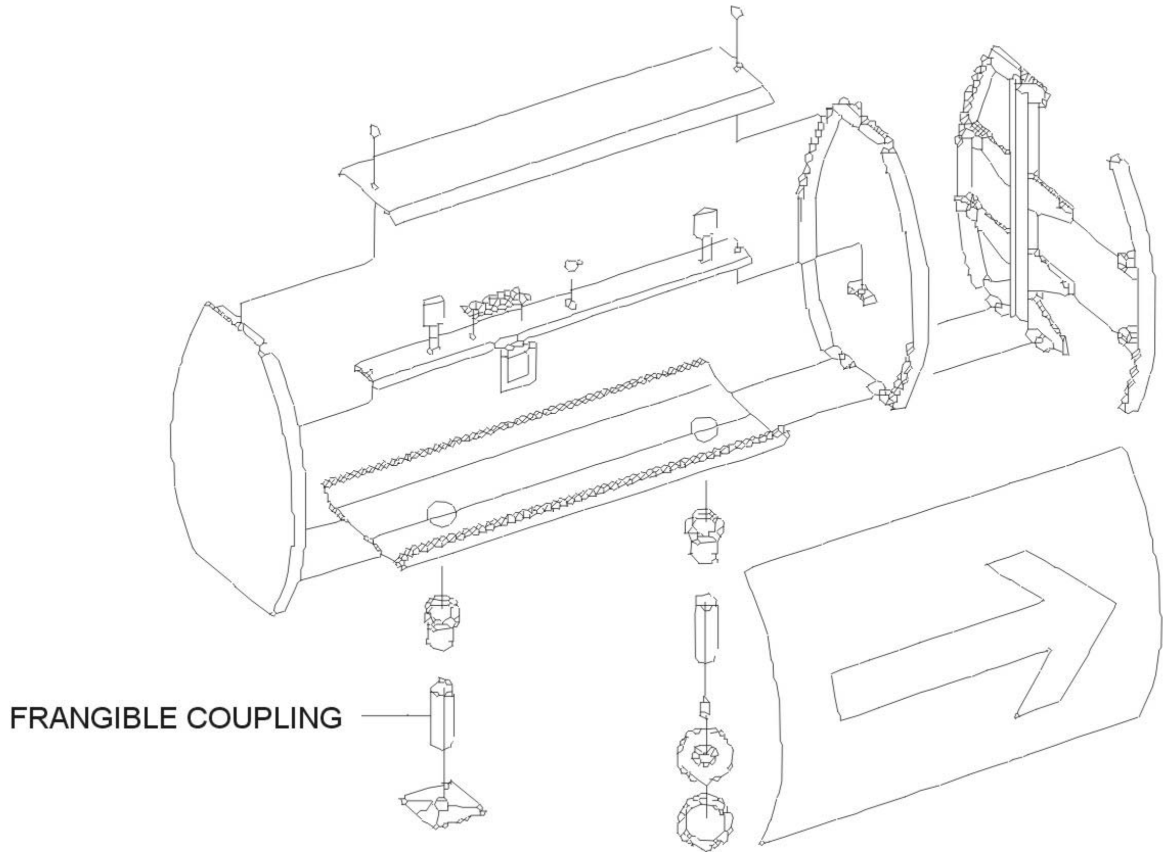
7.5. Tactical Air Navigation (TACAN) Sign. TACAN checkpoint signs provide information for the pilot who is verifying the operation of the navigational aid in the aircraft before takeoff. These signs include the type of navigational aid, identification code, radio channel, magnetic bearing, and the distance in nautical miles to the transmitting antenna from the checkpoint marking. When ordering, specify structures that meet the requirements of FAA AC 150/5345-44. These signs include a frangible device at the base (see Figure 6).

Figure 6. TACAN Sign.



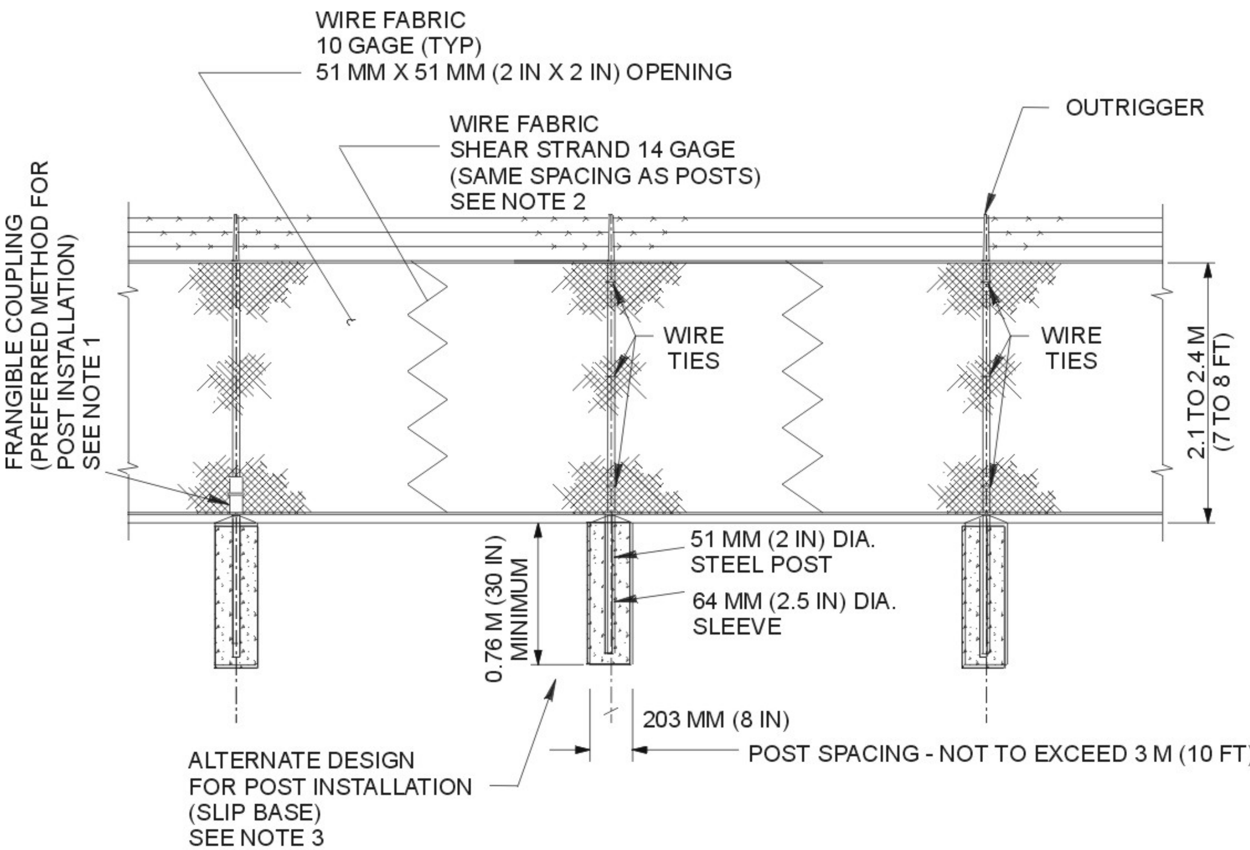
7.6. Taxiway and Airfield Signs. Taxiway and airfield signs are supplied with approved frangible couplings and floor flanges. These devices can be mounted on a concrete pad or with stakes. Sign legs consist of standard 50-millimeter (2-inch) aluminum pipe couplings connected to frangible couplings screwed into floor flanges (feet) or a base plate. The frangible couplings are designed to break at a total force of approximately 5200 foot-pounds (23.1 kilonewtons) (see Figure 7).

Figure 7. Taxiway and Airfield Sign.



8. Conceptual Designs for Frangible Structures. The following figures illustrate additional frangible designs for structures for which testing has not been concluded. However, these designs provide a means to incorporate frangibility into new or existing structures where no frangible design was available in the past. These designs will be updated and additional designs will be added as the Air Force frangibility study progresses.

Figure 8. Frangible Fence.



1. FENCE POSTS FITTED WITH FRANGIBLE COUPLINGS IS THE PREFERRED METHOD OF INSTALLATION.
2. MULTIPLE SHEAR STRANDS (IN WIRE FABRIC) ARE NEEDED TO MITIGATE AIRCRAFT RIDEUP OR CHANGE IN DIRECTION. TYPICAL CHAIN LINK FENCE FABRIC IS GAGE 10. THE SHEAR STRAND MUST BE A MAXIMUM OF GAGE 14.
3. THE FEDERAL HIGHWAY ADMINISTRATION (FHA) CONSIDERS THE 51-MM (2-IN) STEEL PIPE WITH 64-MM (2.5-IN) PIPE SLEEVE (SLIP BASE) AS "CRASHWORTHY."

Figure 9. Small U-Post Road Sign.

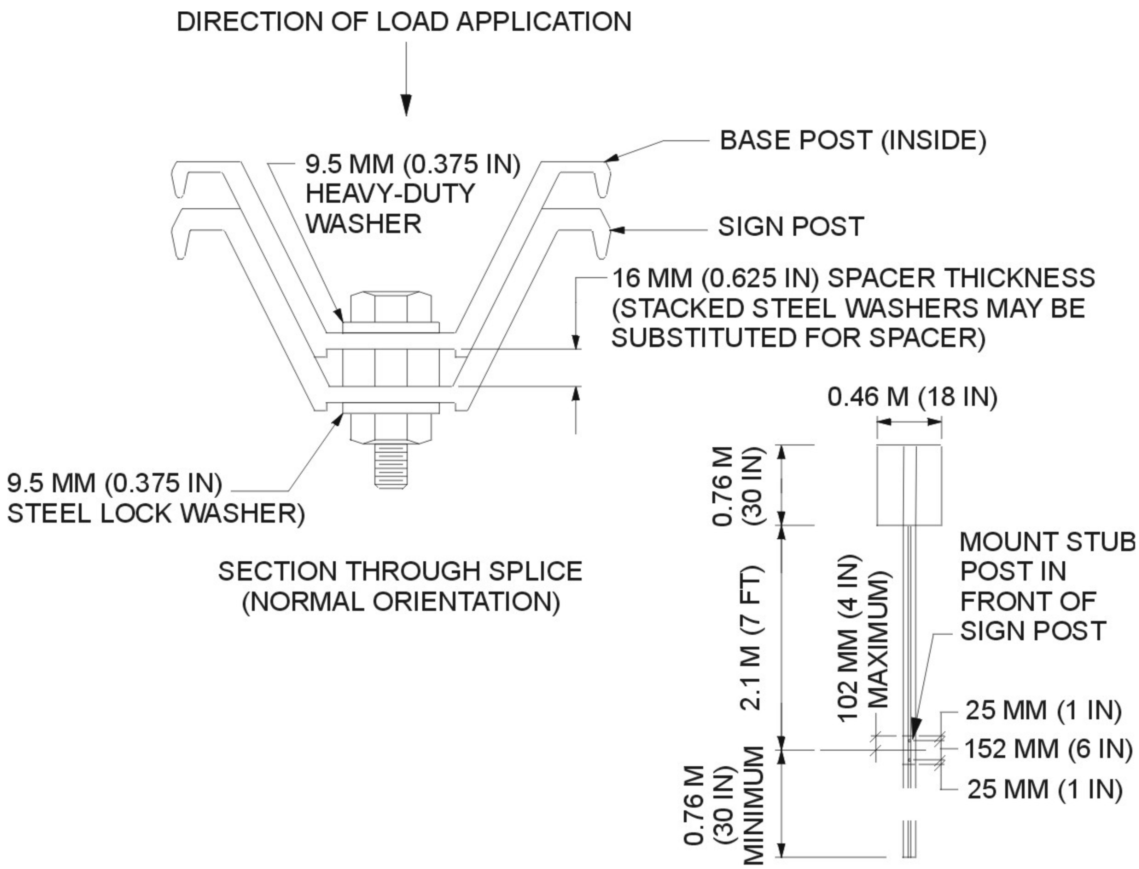


Figure 10. Large Road Sign.

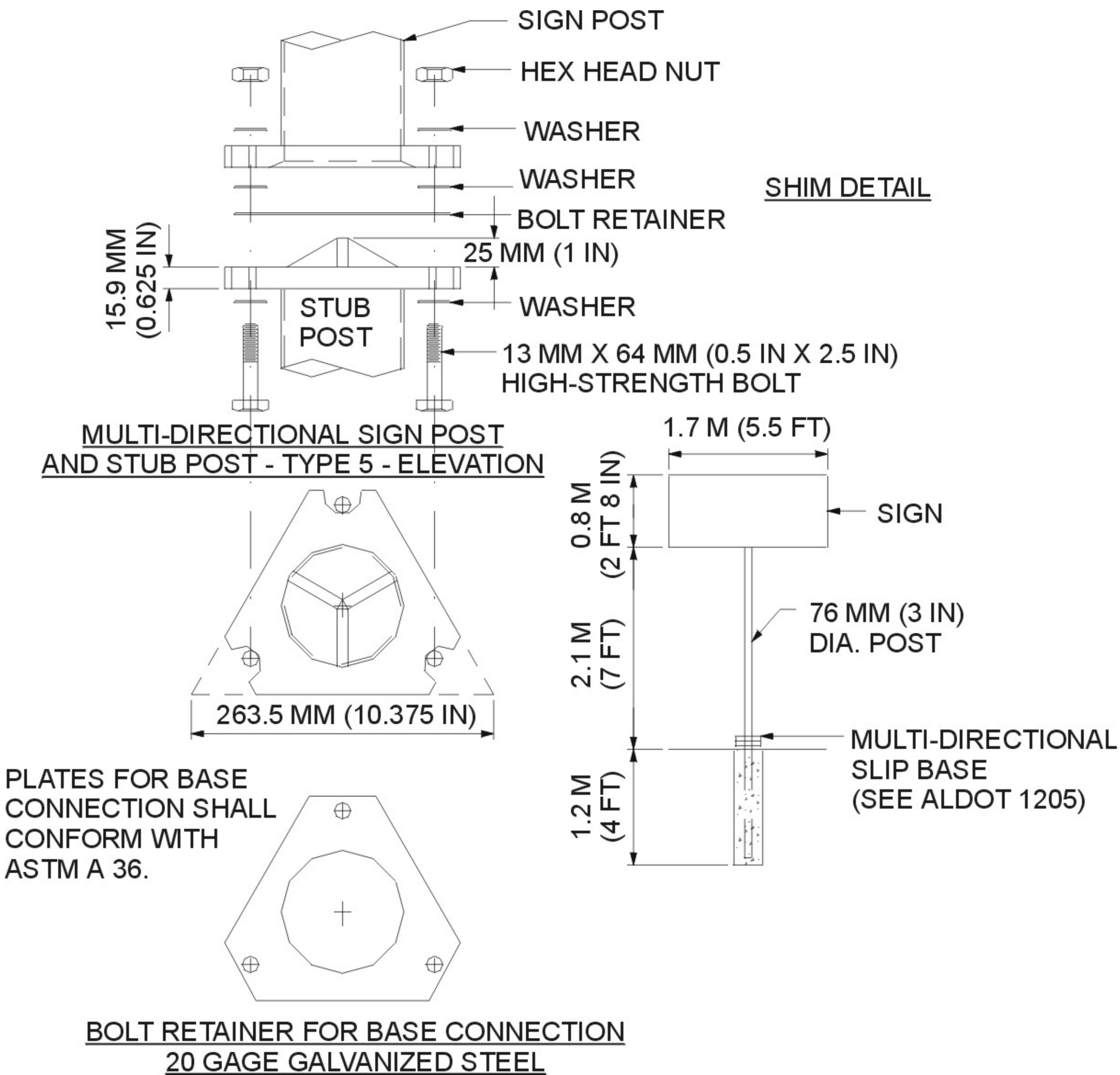
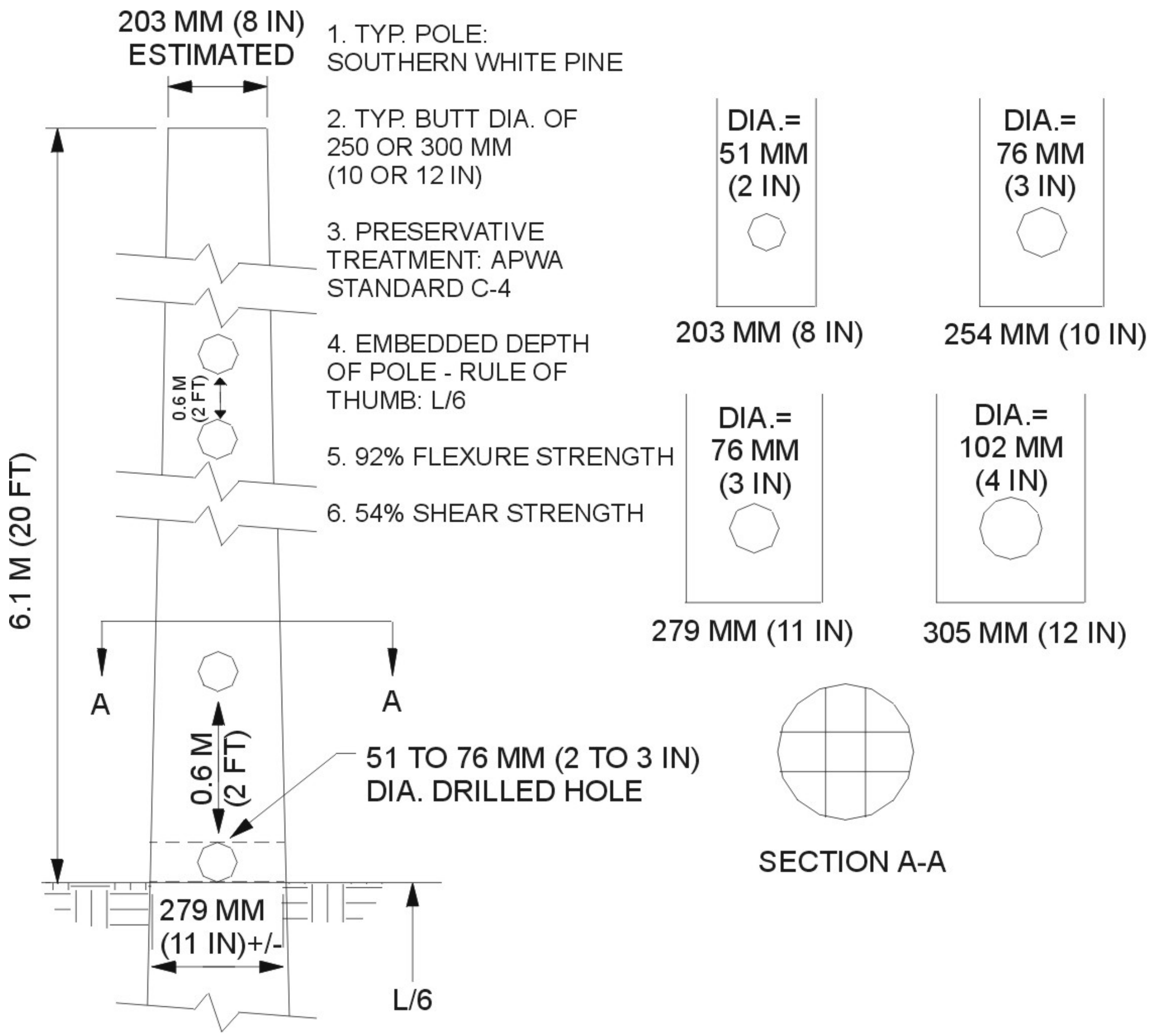


Figure 11. Wood Utility Pole or Livestock Fence Post.



9. Point of Contact. Recommendations for improvements to this ETL are encouraged and should be furnished to: HQ AFCESA/CESC, 139 Barnes Drive, Suite 1, Tyndall AFB, 32403-5319, Attention: Mr. Michael Ates, DSN 523-6351, commercial (850) 283-6351, FAX DSN 523-6219, email mike.ates@tyndall.af.mil.

MICHAEL J. COOK, Colonel, USAF
Director of Technical Support

Atch
1. Coordination sheet

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