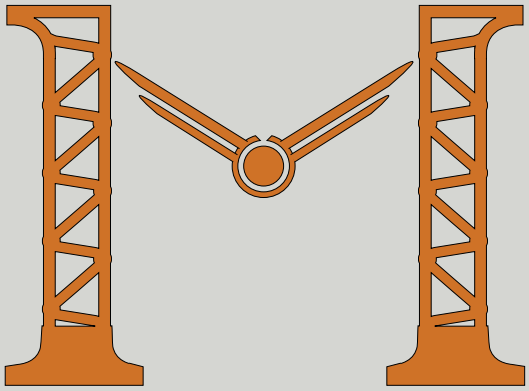


MILLARD TOWERS LTD.

KEEPING THE WORLD ON COURSE SINCE 1951

AVIATION

EN v2.0

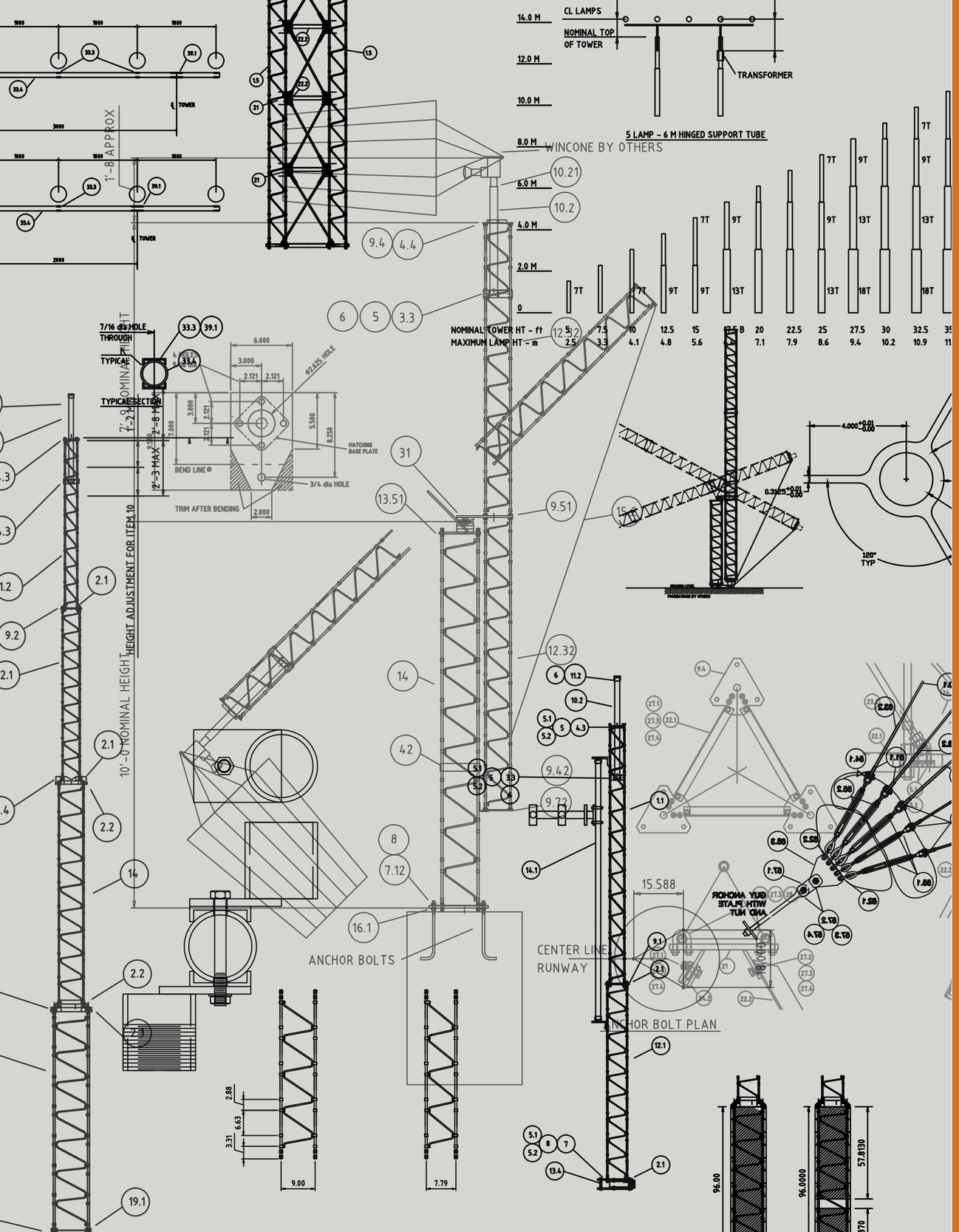

14.0 M
12.0 M
10.0 M
8.0 M
6.0 M
4.0 M
2.0 M
0
CL LAMPS
NOMINAL TOP OF TOWER
TRANSFORMER
5 LAMP - 6 M HINGED SUPPORT TUBE
WINCONE BY OTHERS
NOMINAL TOWER HT - ft
MAXIMUM LAMP HT - m
7/16 dia HOLE THROUGH
TYPICAL
TYPICAL SECTION
HATCHING BASE PLATE
BEND LINE
3/4 dia HOLE
TRIM AFTER BENDING
HEIGHT ADJUSTMENT FOR ITEM 10
10'-0 NOMINAL HEIGHT
ANCHOR BOLTS
CENTER LINE RUNWAY
ANCHOR BOLT PLAN
GUY ANCHOR WITH PLATE AND NUT
120° TYP
15.588

TABLE OF CONTENTS

Established in 1951, Millard Towers Limited has been supplying the world with Aluminum masts used in Aviation, Meteorology, Communication, Defence, Marine, Security, Industrial, and Mobile applications. The masts are favoured for their reliable safety, simple construction, and uncompromised durability in all climatic conditions, particularly regions with high wind, ice, UV and saltwater exposure.

Millard's frangible masts employ the same engineering principles as the rest of its product line, but has been stringently designed and tested to meet ICAO and FAA frangibility standards. The masts are the optimal choice for airports as they meet required international standards, are cost-effective to install, easy to maintain, and offer a great return on investment. In addition, the recycled content, future recyclability, and extended lifespan aid in airports meeting green initiatives.

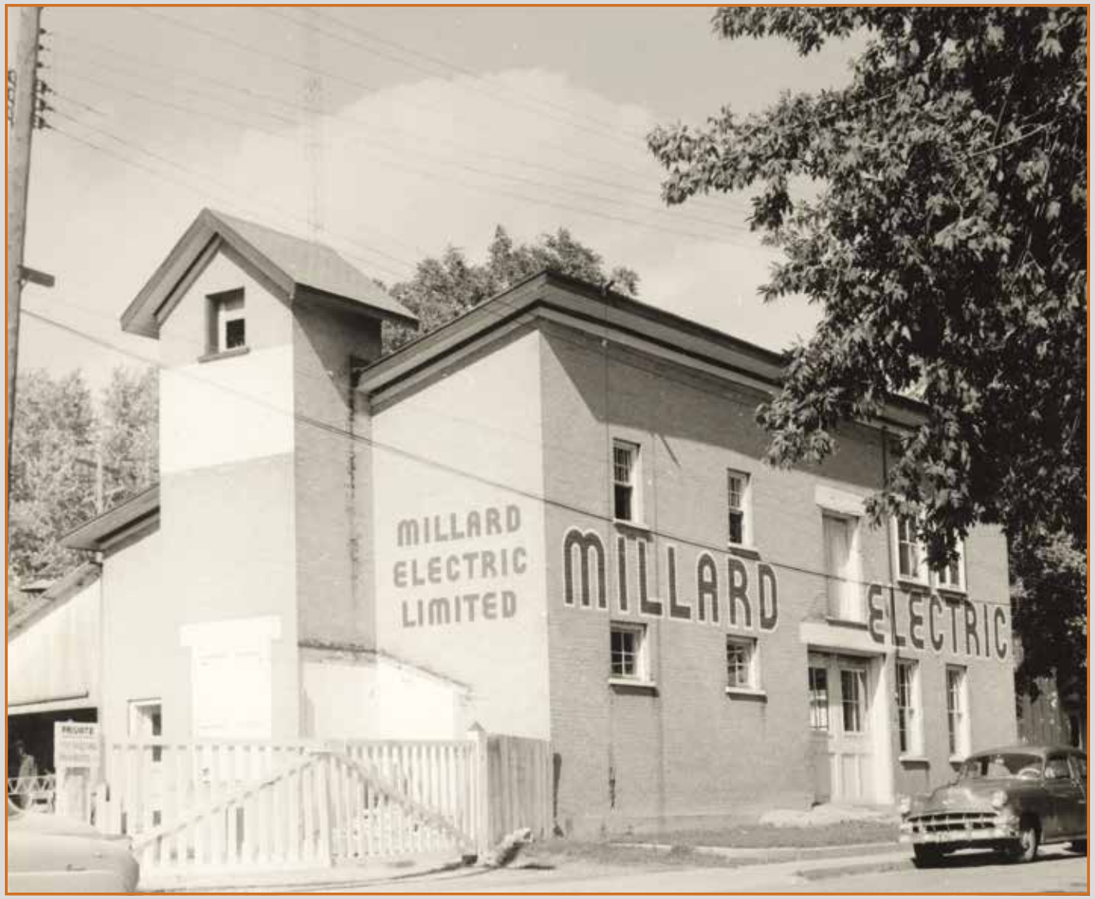
TYPICAL AVIATION APPLICATIONS:

FRANGIBLE :

+ Approach Lighting Systems
+ Meteorology, AWOS
+ Meteorolgy, RVR
+ Meteorology, LLWAS
+ Windsocks
+ ILS Localizers
+ ILS Glide Path
+ Near-Field Monitors
+ Far-Field Monitors
+ DME Antennas
+ MLAT Systems
+ Cameras
+ FOD Sensors
+ Floodlights
+ Signage

NON-FRANGIBLE:

+ Windsocks
+ Meteorology
+ Cameras / Security
+ Communications
+ Antennas
+ Non-Directional Beacons
+ Floodlights
+ Portable Lighting
+ Runway Closure Markers
+ Mobile Power
+ Telescoping Masts
+ Portable Signage



The company was founded by its namesake - engineer, inventor, and pilot John Millard. Located in Perth, Ontario, Canada, Millard started out winding transformers for aircraft during WWII. It wasn't until 1951 when Millard began building its first masts.

Starting out, Millard specialized in communication, surveying, and marine navigational aid support structures. Millard's Aluminum masts offered significant advantages and soon became well renowned in the industry by amateurs and professionals alike. They became a staple for Canadian and American military and marine operations.

The masts featured a unique, prefabricated Aluminum skeletal structure that, through a special fabrication process, retained the strength of the original components and thus, able to withstand even the harshest environments. Sections were light enough to carry by hand making them easy to transport and install in difficult terrain and hard-to-reach sites. As a testament to the design, it is only recently that some of the original installations have been replaced.

An avid pilot, Mr. Millard noted the sharp rise in airplane use and recognized the growing need for safer airfields. With runway excursions increasing, Millard developed masts that could provide the required support for airfield equipment, yet yield if impacted. The design represented a significant improvement in airfield safety, especially when compared to the typical wood and steel structures of the day. These masts would later undergo significant testing where Mr. Millard's original calculations and testing would be confirmed. The design and its testing would later be incorporated into ICAO Doc 9157 Part 6: Frangibility over 50 years after Millard's original design.

Frangible masts are used for Approach Lighting, Meteorology, Instrument Landing Systems, and Windsocks, amongst other airfield applications.

Although the namesake passed in 1990, the company still employs many of the engineering, design, and manufacturing principles that made Millard products innovative and of the highest quality. In addition to a continually growing list of offered designs and services, many of the product lines developed in the early days are still actively sold and supported:

- Communication masts can be found in hundreds of sites around the world
- Marine Navigation support structures number in the thousands along the MacKenzie River and throughout the shorelines of Canada
- Frangible Aviation masts can be found in over 500 airports and 65 countries worldwide

Today, the company's head office and factory are located in Cobourg, Ontario, Canada.

Frangible masts are made from two materials - Aluminum or Fiberglass (GRP). Although designs will vary from company to company, the performance of each design is still dependent upon each material's inherent properties.

The majority of parts and assemblies found in the aerospace indsutry are constructed from Aluminum. This is largely due to the requirement to be of minimal mass, yet still withstand heavy loading, high exposure to UV and moisture, and extreme temperature fluctuations. Much the same can be said about the demand on frangible masts - they must be durable in all environmental conditions to support critical equipment, yet be of minimal mass in order to yield if accidentally impacted.

Millard manufactures its masts and their components from Aluminum - a major contributor to the company's reputation for quality and durability.

BENEFITS

STRONG: Higher strength-to-weight ratio than Steel

LIGHTWEIGHT: Allows for low-cost shipping and easy in-field handling

SOFT: Malleable properties make it ideal for frangibility

DURABLE: Impervious to corrosion caused by water and UV i.e. intrusion, oxidization, degredation

LONGEVITY: Long lifespan with little required maintenance

GREEN: Made from recycled materials and is 100% recyclable

RELIABLE: Mature industry where material is consistent and dependable

MANUFACTURABILITY: Easy to work with and does not require climate controlled facility

MATURE: Material properties have long been established and are well documented

STABLE: Remains structurally unchanged at the molecular level when exposed to high UV

NON-FERROUS: Non-sparking in the event of an accident

The aerospace industry has become known for its large environmental impact and carbon footprint. To combat this, many airports have made it a priority to undertake green initiatives both in the terminal and in the airfield. Although Millard masts are typically chosen for their reputation of quality, their environmental impact should not be overlooked.

Millard uses Aluminum comprised of 25% primary Aluminum ingots and 75% recycled content, including greater than 25% post-consumer content. Greater recycled content translates to a global reduction in bauxite mining. It also requires less energy when compared to extraction processes.

The durability of Aluminum results in a longer lifespan compared to Fiberglass (GRP). A Millard mast will typcially last between 25 and 30 years, although it is not uncommon to see a 40+ year old mast in the field. This results in fewer replacements of the mast and its infrastructure and subsequently, greatly reduces usage of our Earth's finite resources.

When the lifecycle is complete, Millard masts can be easily recycled. Millard masts are made from 100% recyclable Aluminum. While other materials boast recyclability, Aluminum has a mature secondary market with widely available, local recycling facilities. This compares to Fiberglass (GRP) that ends up in a landfill or requires specialized recycling facilities that are far from commonplace.

Traditional support structures for aerodrome equipment, such as Approach Lights, ILS Localizers, and Meteorology Equipment were made from steel and wood. Although strong enough to meet stringent deflection criteria, the structures imposed a safety hazard to aircraft, particularly equipment located in close proximity to an aircraft's flight path. In the event of an impact, an aircraft would be damaged to the point that take-off or landing could not be continued safely. In an effort to mitigate the consequences of runway excursions, ICAO released Doc 9157 AN/01, Chapter 6: Frangibility in 2006.

Traditional Non-Frangible Approach Light Mast

ICAO DOC 9157 REQUIREMENTS

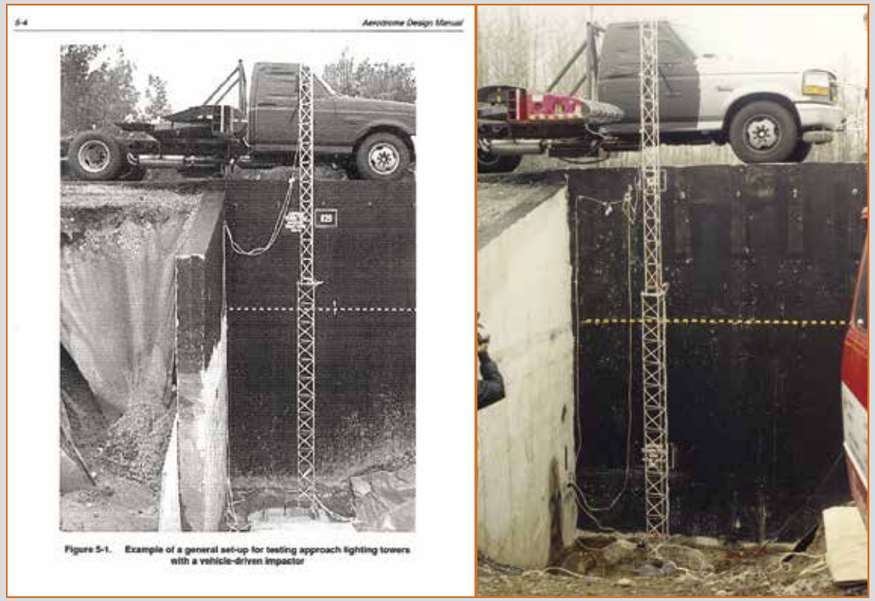
APPLICATIONS: Approach Lights, Windsocks, Meteorology, ILS Localizers, ILS Glide Path, and other Aids to Navigation located in the airfield.

CRITERIA: Not impose a force >45kN and impart energy >55kJ, allowing the aircraft to continue its course without losing momentum, changing direction, or suffering structural damage. Frangibility can be achieved by breaking, distorting, or yielding and must not create a risk of secondary impact.

TESTING: Static evalation can be used for all structures <1.20m. For structures >1.20m, full-scale impact testing should be undertaken and verified using Finite Element Analysis (FEA). Testing is the responsibility of the manufacturer.

PERFORMANCE: Structures should be built to withstand survival wind and ice loads in accordance with local standards while also meeting equipment specifications (i.e. deflection) under operational environmental conditions.

In 1951, over 50 years before ICAO Doc 9157 was implemented, Millard recognized the importance of airfield safety and engineered the world's first frangible masts. Millard has achieved ICAO compliance through 3rd party full-scale impact testing - a requirement of ICAO Doc 9157. In fact, ICAO used Millard masts as a benchmark for designing and testing frangibility. Images of Millard masts can be found within Doc 9157 as examples of proper frangilbe design and testing procedures.



5-4 Aerodrome Design Manual

Figure 5-1. Example of a general set-up for testing approach lighting towers with a vehicle-driven impactor

Page excerpt from ICAO Doc 9157 (left) alongside a photo from Millard's frangibility testing (right).

For the over 65 years Millard masts have been used at airports, over 40 accidents have occurred involving direct impact between the aircraft and the masts. In each impact, Millard masts failed as engineered by safely giving way without risk of secondary impact. What is even more impressive is the range of aircraft and applications involved in the accidents – from private pleasure crafts to commercial airliners and from Approach Lights to ILS Localizers.

Millard Approach Light masts lay broken after being impacted during an overshot approach.

Located at the end of runways where accidental impact is most likely to occur, Millard masts are yielding, but rigidly support approach lights to required ICAO deflection criteria - ± 2° vertical and ± 5° horizontal. Standard designs are available up to 14m and can be configured to support a variety of individual lamps and crossbars. Above 14m, Millard offers XTALL solutions that are both fixed and tiltable. All masts have a standard wind and ice loading of 170km/h and 12.5mm of radial ice. Custom solutions are available.

ICAO DOC 9157, PART 6:

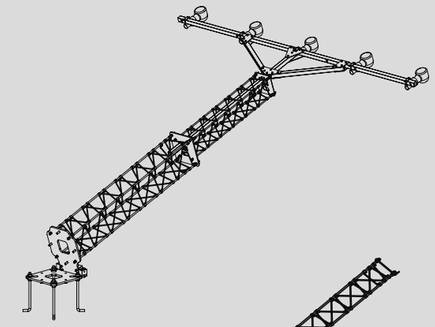
1.3.2: Elevated approach lights and their supporting structures should be frangible.

4.9.19: Any approach lighting structure required to be frangible should be designed to withstand the static and operational/survival wind loads with a suitable factor of safety but should break, distort or yield readily when subjected to the sudden collision forces of a 3,000kg aircraft air and travelling in any direction at 140km/h.

5.2.8: Navigational aids having an overall height over 1.20m should be verified for frangibility by dynamic testing. Tests should be conducted with a vehicle-driven impactor.

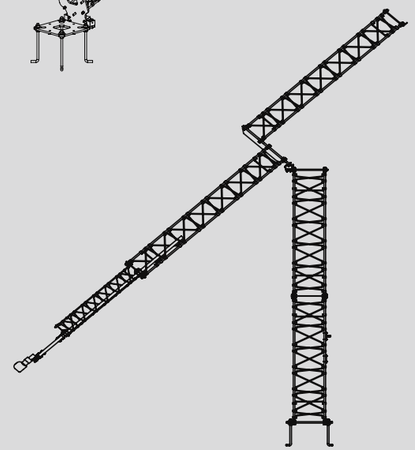
Millard offers two designs – single lamp and lightbar - to ensure that masts are of minimum mass as ICAO specified. Triangular sections are used for single steady-burning, flasher and ODAL lamps. Square sections are used for crossbar positions where multiple lamps must be fitted on a single lightbar up to six meters in length. The modular design is well-suited for all approach configurations. All masts provide in-field lamp height adjustment of +800mm.

Serviceability features are simple and reliable. A tilt base feature allows for installation without a crane, while a center hinge design provides a mechanical, safe and easy alternative to climbing or using a service truck / crane for lamp maintenance. All lowering features are designed to be operated by 1-2 technicians.



Some typical Approach Light System layouts include:

+ ODALS
+ Simple
+ MALSR
+ SSALR (CAT I)
+ Barrette Centreline (CAT I)
+ Calvert (CAT I)
+ ALSF-II (CAT II & III)
+ Barrette Centreline (CAT II & III)



Fabricated from Aluminum, Millard masts are well-suited for meteorology applications. Made from the same alloy as many meteorological equipment, masts are built to withstand extreme environmental conditions without compromising performance.

Masts come in a variety of standard heights and designs to meet specific application requirements:

APPLICATION	HEIGHT	DESIGN	SERVICING OPTIONS
RVR	2.50m	225A	TILT BASE
AWOS	3.00m	300A	TILT BASE
AWOS	6.00m	525A	TILT BASE CENTER HINGE
AWOS	10.00m	900A	TILT BASE CENTER HINGE

Custom heights and applications are available.

ICAO DOC 9157, PART 6:

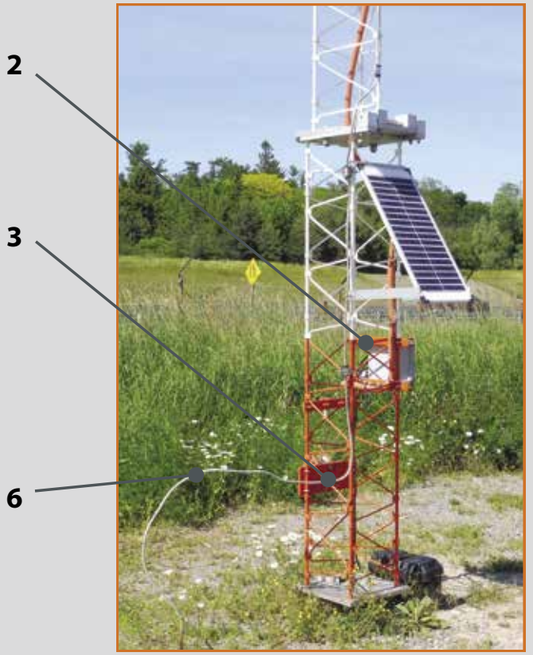
1.3.6 and 2.1.12: Approach Light frangibility standards should be applied to AWOS / Anemometer masts as they are located in the operational area of an airfield.

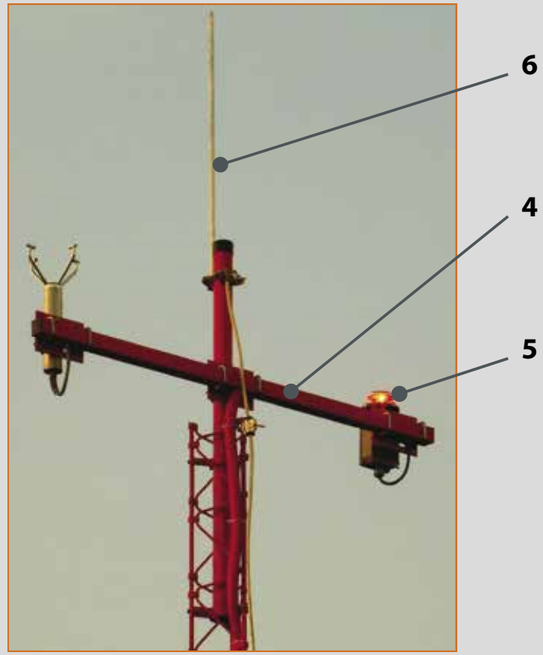
5.2.8: Navigational aids having an overall height over 1.20m should be verified for frangibility by dynamic testing. Tests should be conducted with a vehicle-driven impactor.

5.3.1: Full-scale testing is complex and costly; however, it is the manufacturer's responsibility to carry out these tests.

In addition to the frangible mast, Millard also offers a complete line of engineered accessories to ensure installations are aesthetically appealing, complete, and fully compliant. Accessories include:

1. **FOUNDATION KIT (not shown):** Wood template and anchor bolts for concrete installations.
2. **JUNCTION BOX / DATA LOGGER MOUNT:** Adjustable mounting brackets to support enclosures.
3. **REMOVABLE WINCH:** Wormgear winch for mechanical lowering of mast.
4. **CROSSARM:** Mounting for meteorolgical equipment and obstruction lights.
5. **OBSTRUCTION LIGHT:** Available as a single or double red LED. Includes mounts.
6. **LIGHTNING KIT:** Passive system engineered to NFPA 780 standards.





Millard manufactures a complete line of Windsocks, including poles and frangible masts.

WINDSOCK ASSEMBLY

Millard's Windsock Assembly employs the same engineering principles that have made its masts renowned for quality. The swivel is built with high-grade materials and designed for optimal performance. Assemblies have been stringently tested and are fully compliant with ICAO, FAA, and Transport Canada structural and photometric requirements.

POWER SUPPLY	DIAMETER (m)	STANDARD		
		ICAO	FAA	TC
UNLIT	0.45	-	Size 1, Style II	Size 2
	0.60	Heliport	-	Heliport
	0.90	Airport	Size 2, Style II	Size 1
100-240 VAC	0.45	-	Size 1, Style I-B	Size 2
	0.60	Heliport	-	Heliport
	0.90	Airport	Size 2, Style I-B	Size 1
2.8-6.6 A	0.45	-	Size 1, Style I-B	Size 2
	0.60	Heliport	-	Heliport
	0.90	Airport	Size 2, Style I-B	Size 1
12 VDC	0.45	-	Size 1, Style I-B	Size 2
	0.60	Heliport	-	Heliport
	0.90	Airport	Size 2, Style I-B	Size 1

FRANGIBLE MASTS

Frangible windsock masts are manufactured to ICAO and FAA frangibility specifications and made from high-grade Aluminum alloy. The unique lattice structure offers rigidity in high winds, but is yielding if accidentally impacted by an aircraft. The mast comes equipped with either a tilting base or an elevated hinge. Both provide easy servicing for windsock maintenance and replacement.

ALUMINUM POLES

When frangibility is not required, Millard's robust Aluminum poles can be used to support windsock assemblies. The design is not subject to warping or bending casued by long-term fatigue as is the case with other windsock supports. For servicing, all designs come with a tilt base that allow it to be raised and lowered by hand. An optional center hinge operates using a winch and allows the pole to be raised and lowered by a single technician.

DESIGN	AL POLE		AL FRANGIBLE MAST		GRP FRANGIBLE POLE	
HEIGHT	2.25m	4.50m	2.25m	4.50m	2.25m	4.50m
SERVICEABILITY						
FIXED BASE	-	-	✓	✓	-	-
TILT BASE	✓	✓	✓	✓	✓	✓
CENTER HINGE	-	✓	-	✓	-	-
WALL MOUNT	✓	✓	-	-	-	-
PORTABLE TRIPOD	✓	✓	-	-	-	-
STANDARDS						
ICAO / FAA / TC FRANGIBILITY[2]	-	-	✓	✓	✓	✓
FAA STANDARD	L-806	L-807	L-806	L-807	L-806	L-807

SOLAR ENGINE POWER SUPPLY (SEPS)

Powering windsocks in the airfield can be costly. Running cable during installation and ongoing energy costs can add up. As an alternative, Millard's SEPS units offer simple installation and stand-alone power. The solar kits are conservatively engineered ensuring a minimum of 10 days of autonomy even in low photovoltaic regions.

ILS LOCALIZER

ILS Localizers are located at the end of the runway directly on the flight path. Considering this risk, localizers should be made frangible. Millard offers a modular Aluminum design that has minimal deflection yet yields if accidentally impacted. The double mast structure is engineered to minimize deflection to half of a degree under operational conditions.

Solutions are offered in 75cm increments. Mast sections are fabricated in maximum 3m lengths and the modularity allows them to be nested within each other to optimize shipping. In-field assembly comprises of minimal assembly - typically six (6) nuts per mast for solutions under 6m. In addition to masts, Millard also offers other accessories such as obstruction lights, cable trays, and custom mounts.

ICAO DOC 9157, PART 6:

1.3.6 and 2.1.7: Approach Light frangibility standards should be applied to ILS Localizer masts as they are located in the operational area of an airfield.

4.9.31: Current designs prove that lightweight modular designs can be used to limit mass on ILS Localizer installations. The design criteria associated with a 3,000kg airplane (approach light testing) should be used for ILS Localizers.

5.2.8: Navigational aids having an overall height over 1.20m should be verified for frangibility by dynamic testing. Tests should be conducted with a vehicle-driven impactor.

5.3.1: Full-scale testing is complex and costly; however, it is the manufacturer's responsibility to carry out these tests.

ILS GLIDE PATH

Millard's Glide Path design is made of frangible sections, yet maintains a maximum half degree of deflection under operational conditions ensuring reliable performance of the supported antennas.

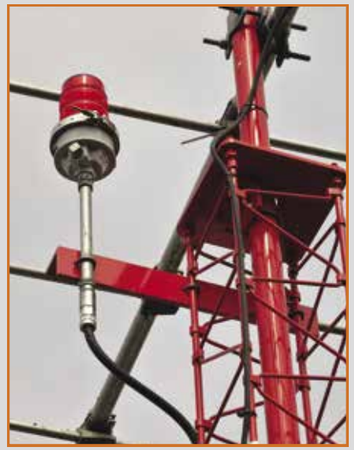
Depending on heights, masts are built as either a double or triple mast structures, thereby minimizing its footprint. Solutions are offered in 1.50m increments and can be equipped with an optional ladder, obstruction light, cable guides, and adjsutable antenna mounts. Sections are pre-fabricated in maximium lengths of 3m to ease the cost of shipping and installation.

NEAR-FIELD MONITORS, FAR-FIELD MONITORS, DME ANTENNAS

Millard's frangible masts can also be used for Near-Field Monitors, Far-Field Monitors, and DME Antennas. Similar to other ILS equipment, these applications have stringent deflection requirements. Millard frangible masts have been thoroughly analyzed and tested to meet these requirements with over 65 years of experience .

Masts are built in 75cm increments with a maximum deflection of half a degree under operational conditions.

Masts come equipped with a variety of different tilting features and mounts to simplify installation and servicing.



ICAO DOC 9157, PART 6:

4.9.11: When the height required exceeds 12m, frangiblity only needs to apply to the upper 12m.

When applications require a mast greater than 12m, ICAO requires only the upper 12m to be frangible. For these designs, Millard has engineered various Hot-Dipped Galvanized Steel solutions that act as the base and support the frangible 12m. Depending upon the overall height and customer preference, a variety of designs are available.

FIXED BASE

For airports that have access to a bucket / service truck, frangible masts can be supported by a Fixed Steel design. A column structure is used to provide rigid support for the frangible mast above it. Solutions are available for heights up to 30m. Masts that exceed 30m require special study.

TILTABLE BASE

For masts up to 30m, frangible masts can be supported by a tiltable base that allows the mast to be lowered to the ground for maintenance. Masts use counterweights and are availble with either a rope and pulley or a mechanical winch for easy lowering by a single user.

TILTABLE FRANGIBLE MAST ON STEEL LATTICE SUPPORT

For heights above 20m, tiltable frangible masts can be installed on top of platform supported by a Steel lattice tower. The frangible mast is designed to lower directly below onto the platform to allow for servicing. Solutions have been provided for 20m to 120m.

FRANGIBLE MAST ON ELEVATOR

For heights above 25m, a Millard frangible mast can be installed on an elevator. The elevator can be raised and lowered from a service platform approximately 14m above grade. Solutions have been provided for heights of 25m to 120m.

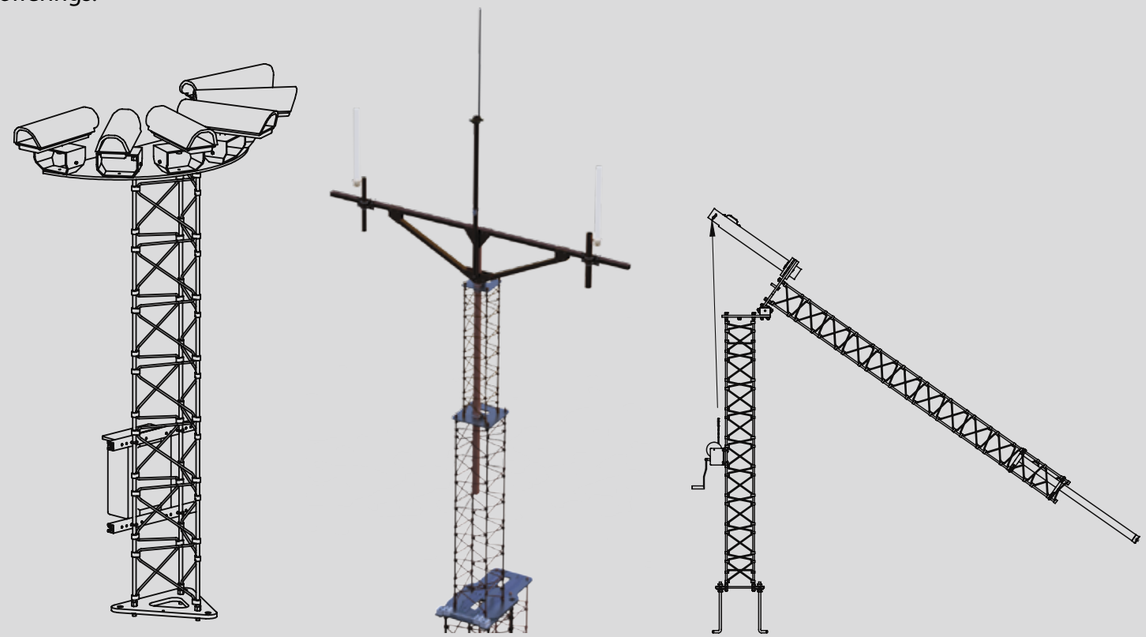
Regardless of the design, customers should work closely with Millard to ensure all variables are considered. Wind and ice loads, equipment size, weight and performance requirements, maintenance access, and terrain are examples of some factors that will have an effect on the final design.

In addition to typical frangible structures, Millard is experienced in supplying bespoke frangible solutions for unique airfield applications. Millard's modular design can be configured to support a range of equipment sizes, while being subjected to extreme environmental conditions.

SAMPLE APPLICATIONS :

+ Multilateration (MLAT)
+ Foreign Object Debris (FOD) Detection System
+ Cameras - Security
+ Cameras - Remote Tower
+ Beacons
+ Signage - Taxiway and Aprons
+ Off-Grid Power - Solar, or Wind
+ Lighting
+ Antennas, or Communications

Working closely with our clients, Millard's engineering department models designs using the latest 3D CAD software to ensure proper fit and function. Afterwards, Finite Element Analysis (FEA) is undetaken to confirm performance and compliance to specified standards. In-house manufacturing produces not only our frangible sections, but is also suited to fabricate custom mounts and accessories. Additive manufacturing capabilities also make Millard an ideal partner in developing prototypes and turning them into standardized offerings.



In addition to design and fabrication services, Millard can also aid in engineering on-site solutions such as:

+ Temporary installations
+ Mobile applications
+ Civil works and foundations
+ Off-grid power
+ Condition assessment reporting
+ Site inspections

In addition to its frangible masts, Millard also offers non-frangible designs for aviation applications that are located outside of the airfield safety areas. Millard's design and fabrication services are performed internally and at a single site, making it an ideal partner for custom aviation solutions.

SAMPLE DESIGNS:

+ Tiltable Poles
+ Telescoping Poles
+ Tiltable Masts
+ Guyed Masts
+ Tripods
+ Roof Mounts
+ Trailer Mounted Applications

SAMPLE APPLICATIONS:

+ Meteorology
+ Windsocks
+ Solar & Wind Power
+ Security / Cameras
+ Lighting
+ Beacons
+ Portable Lighting / Power / Signage
+ Runway Closure Markers
+ Communications / Antennas

Millard Towers has established a global reach with installations at over 500 airports in over 65 countries worldwide - a testament to over 65 years of quality engineering and manufacturing.

NORTH AMERICA

Anguilla (2)
Aruba (1)
Bermuda (1)
Canada (228)
Cayman Islands (1)
Costa Rica (3)
Cuba (1)
Curacao (1)
Granada (1)
Mexico (4)
Panama (5)
Saint Vincent and the Grenadines (2)
Trinidad and Tobago (1)
United States of America (58)

EUROPE

France (1)
Greece (1)
Italy (23)
Macedonia (3)
Poland (1)
Portugal (1)
Slovakia (4)
Spain (17)
Ukraine (2)
United Kingdom (5)

AFRICA

Angola (2)
Cote d'Ivorie (1)
Libya (3)
Madagascar (1)
Mali (1)
Morocco (2)
Mauritius (1)
Nigeria (3)
Sierra Leone (1)
Tunisia (1)
Zambia (2)

ASIA

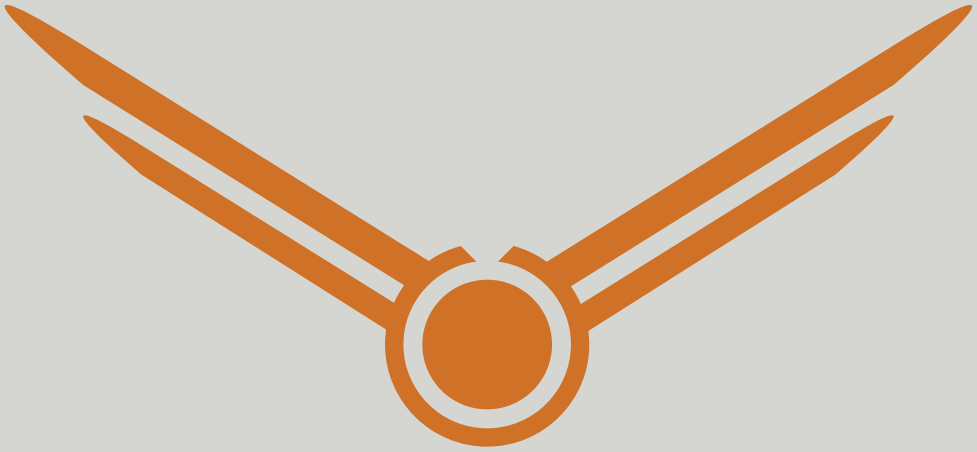
Afghanistan (5)
Cambodia (1)
China (26)
Egypt (1)
Hong Kong (1)
India (3)
Indonesia (5)
Israel (4)
Japan (3)
Jordan (1)
Kazakhstan (5)
Kuwait (1)
Malaysia (2)
Maldives (1)
Nepal (4)
Saudi Arabia (12)
South Korea (3)
Taiwan (8)
Thailand (9)
Turkmenistan (1)
United Arab Emirates (2)
Vietnam (15)

SOUTH AMERICA

Argentina (6)
Bolivia (1)
Colombia (25)
Chile (2)
Peru (2)
Uruguay (3)

OCEANIA

Australia (1)
Kiribati (1)
New Zealand (3)
Solomon Islands (1)
Tuvalu (1)



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