WATTS ANTENNA COMPANY

.... World Leader In Advanced ILS Antennas

Operational Benefits and Applications of End-Fire Glide Slope (EFGS) Antenna Systems

About EFGS Antenna Subsystems

End-fire is an antenna term used to describe an array that radiates off the end of its major axis.

Watts Antenna Company Is The Sole Source Manufacturer & Provider Of End-Fire Glide Slope Antennas Worldwide.

Our End-Fire Glide Slope (EFGS) is a non-imaging end-fire type antenna system where the major axis is essentially parallel to the runway.

The characteristics of Watts Antenna Company's EFGS antennas offer many significant advantages over conventional image glide path (GP) systems including narrow beamwidths and the ability to be optimized for performance within each individual and unique site environment.

EFGS Applications

Economically Growing Sites

End-Fire systems provide airports with cost effective Instrument Landing Systems (ILS) to support airport and economic growth, important to local and regional marketplaces. These systems provide final approach glide path information to a landing aircraft, enabling the pilot to maintain a constant descent angle for landing at the desired category of approach.

EFGS Applications *(Cont'd)*

Challenging Siting Environments

Our EFGS systems are optimum at sites where the terrain is physically unsuitable, environmental regulations prohibit earth moving, or it is not economically feasible to prepare the required ground plane for an image-type glide slope. In these situations, the Watts Antenna Company's EFGS antenna system is the answer. That's why we are known as … *'the tough site solution'*.

EFGS Applications *(Cont'd)*

Ground Plane Limited Sites

Our EFGS systems are essential for runways having a limited amount of flat terrain such as in the case of hillside, mountainous, or waterside locations as well as densely developed locales. These systems are non-imaging in that the path angle is determined by the relative phase of the signals generated by both the front and rear main antennas. The functioning of the system is essentially unaffected by adjacent low terrain, wetlands or bodies of water with or without tidal variations.

EFGS Applications *(Cont'd)*

Air Traffic Congested Sites

Our EFGS antenna systems are also ideal for airports with congestion and capacity issues due to high volumes of air travel. The narrow RF signal radiated by the EFGS antenna allows taxiing aircraft to move beyond current ILS Critical Area hold short lines even on IFR days without disturbing the signal-in-space. This results in the same throughput capacity on IFR days as you would expect on VFR days because our antennas limit radiation in the direction of the taxiway. Aircraft will no longer need to hold short until they reach the Runway Safety Area (RSA).

Three Distinct EFGS Models To Select From Depending On Your Location's Terrain & Landing Category Requirements

Model 105 End-Fire

- Category I/II
- Non-Image Frangible
- As much as 35+ Years Service Life with refurbishment

Model 106 End-Fire

- Category I
- Non-Image Frangible
- As much as 35+ Years Service Life with refurbishment

Model 107 Upslope End-Fire

- Category I
- Non-Image Frangible
- As much as 35+ Years Service Life with refurbishment
- For Sites with Extreme Rising Terrain

Life Expectancy Of An EFGS

The lifespan of an EFGS is as much as 35+ years and we have a history to prove it! Once the system is installed, tuned and commissioned, our systems operate reliably for years. We are always available to assist and support at anytime including when:

- Relocating the system (*e.g.* runway extension projects)
- Needing parts, repairs or refurbishment
- Training operations, maintenance and support staff
- Assistance is requested

Throughout the entire lifespan of the system, we are available for video conferencing with your staff in the field or in the office. Our main objective is to keep your GP in operation without any notable downtime whatsoever.

Reducing The Beamwidth Decreases The Size Of The GP Critical Area & Potential For Multipath Interference

GP Antenna Sideband Azimuth 3dB Beamwidth Comparisons

- The conventional GP antenna has a ***Symmetric* 3dB beamwidth of 28°** from -14° to +14° azimuth.
- Our Model 105 End-Fire GP antenna has a much narrower ***Asymmetric* 3dB beamwidth of 16°** from -12° to +4° azimuth and produces much smaller Critical & Sensitive Areas.
- Our Model 106 End-Fire GP antenna has the narrowest ***Asymmetric* 3dB beamwidth of 8°** from -6° to +2° azimuth producing the world's smallest GP Critical & Sensitive Areas!

Asymmetric, Narrow Beam Antenna Patterns Vs. Symmetric Broad Beam Antenna Patterns

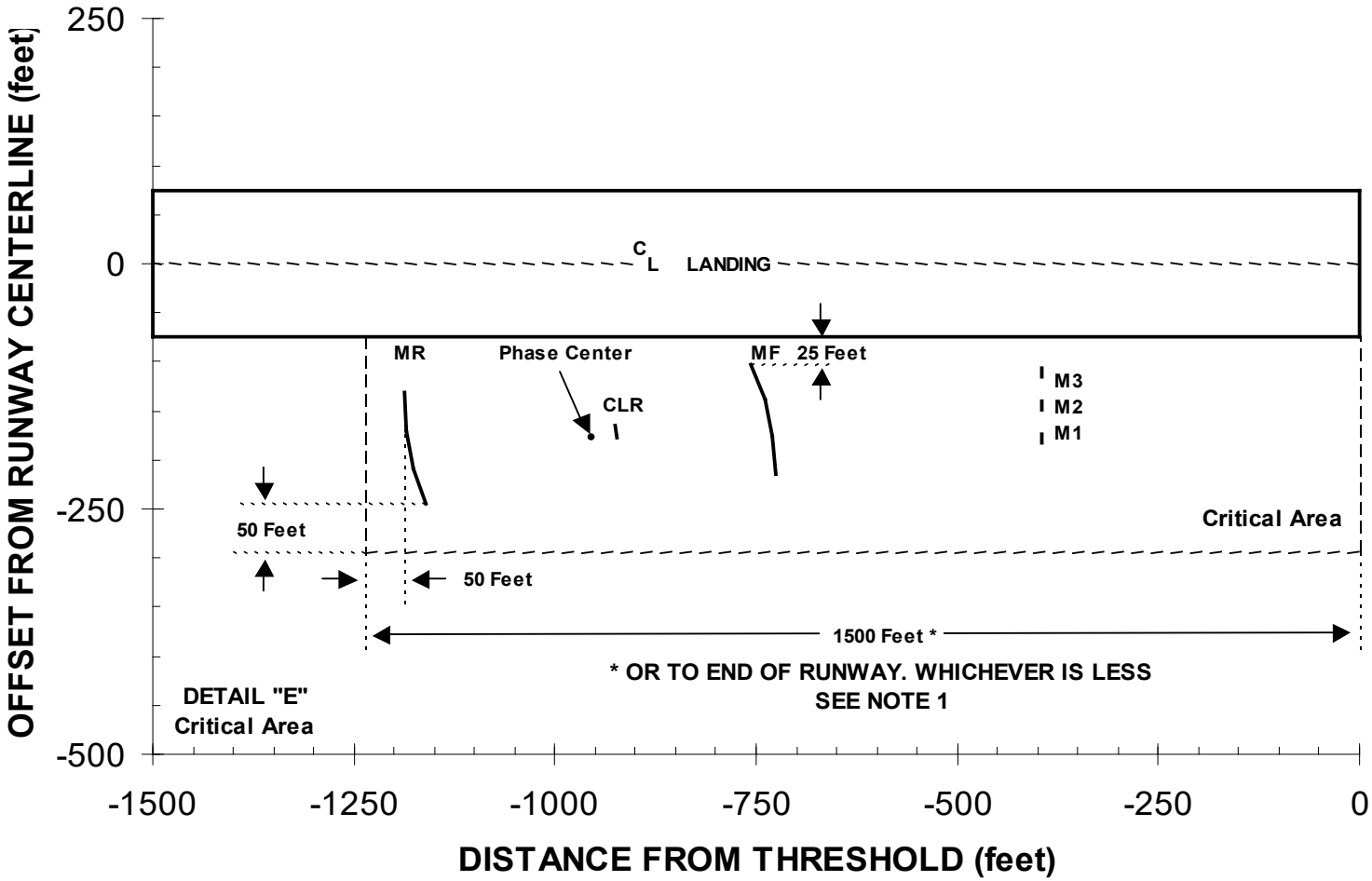
A GP antenna with an asymmetric, narrow beam antenna pattern can be installed on either side of the runway just as a GP antenna with a symmetric, broad beam antenna pattern can. However, the advantage of the asymmetric, narrow beam antenna pattern is that the environment that is illuminated changes quite dramatically depending on which side of the runway it is installed on, while a symmetric broad beam GP antenna pattern illuminates essentially the same area no matter which side is chosen.

This advantage can be beneficial for GP siting with terrain issues in the approach region or for multipath generating objects in and around the airport.

"Why solve an asymmetric problem with a symmetric solution ..."

Reducing The GP ILS Critical Area And Its Impact

Our EFGS has the smallest Critical Area of any Glide Slope. Its narrow beam allows economic development and increases in capacity.



Advantages Of Our EFGS Antennas

The advantages of Non-Image EFGS antennas over Image Glide Path antennas are extensive and results from 4 fundamental features.

Vs.

Non-Image EFGS Antenna

1. Wide aperture arrays radiating asymmetric, narrow RF patterns to essentially eliminate Critical & Sensitive Areas.
2. Proven frangible low-profile arrays permitting placement within the RSA without being in violation.

Image GP Antenna

1. Standard aperture arrays indiscriminately radiating RF patterns creating substantial Critical & Sensitive Areas.
2. Non-Frangible tower mounted arrays requiring waivers for placement within the RSA.

Advantages Of Our EFGS Antennas *(Cont'd)*

Non-Image EFGS Antenna	Vs.	Image GP Antenna
3. Non-Image End-Fire Glide Path arrays function independent of ground planes.		3. Image Glide Path arrays are highly reliant upon extensively conditioned ground planes.
4. Highly adjustable arrays resulting in operationally high performance in nearly all site environments.		4. Minimally adjustable arrays resulting in standard performance in the most favorable site environments.

Picture of Chicago O'Hare by Etienne du Plessis

The End-Fire Mitigates Congestion & Capacity Issues Facing Densely Developing Locales

The ability of our End-Fire systems to reduce the ILS Critical & Sensitive Areas from taxiways and other operationally significant areas, provides opportunities for increased capacity and development to airports and their communities.

Our EFGS Is The Only Truly Frangible GP Array, Even For General Aviation Aircraft!

Our frangibility point lowering kit for the low-profile End-Fire exceeds the FAA's safety requirements for antennas within the Runway Safety Area (RSA). The End-Fire may be your best solution for RSA compliance.

Our EFGS Is A Non-Imaging System That Does Not Require Smooth Earth To Form The Path In Space

Significant cost savings may be achieved by avoiding expensive ground plane conditioning at sites with limited runway shoulder. Our EFGS may quite honestly be "cheaper than dirt" for your site.

An End-Fire Is Perfect For Sites With Limited Longitudinal Ground Plane To Serve Image Systems!

Mountaintop sites where altitudes reach beyond 10,000 feet above sea level are no problem for End-Fire systems. In fact, we currently have an EFGS installed at a site that is over 11,000 feet in altitude.

The Signal Of Our EGFS Is Not Degraded By Tidal Variations, Making It Well Suited For Waterside Sites

For many GP sites, an image system is just not feasible. Our EFGS will provide GP coverage for complex mountainous and waterside environments.

Sites Near Wetlands And Wildlife Habitations Are Prime Candidates For Our EFGS Systems

Install our EFGS to mitigate wildlife and environmental issues involving wetlands, sanctuaries or restrictions against vegetation control where conditions impact image system's performance.

A Site With Accumulated Course Errors That Interfere With An Image GP Is A Candidate For Our EFGS

Our EFGS systems can be adjusted to remove course errors and to allow for improvement projects such as security fencing that otherwise would not be possible with image type systems.

Our EFGS Antennas Reduce The Distance Needed Between A Runway And A Parallel Taxiway

The frangibility of our EFGS antenna allows our system to be installed within the RSA. The comparatively small size of our EFGS antenna's Critical Area allows a parallel taxiway to be constructed closer to our GP antenna than to other GP systems. Therefore, installing our EFGS between the runway and a parallel taxiway will allow the taxiway to be built closer to the runway than with any other GP antenna system. In some cases, it will allow a taxiway to be constructed that would otherwise not be allowed due to limited space at congested airports.

Our EFGS Has Extremely Low "Hazards Of Electromagnetic Radiation" To Ordinance (HERO), To Fuel (HERF), And To Personnel (HERP)

Our EFGS has a wide aperture which spreads the intensity of the radiated signal out, over numerous distributed radiating signal sources.

This allows aircraft loaded with ordinances, fuel, and surrounding ground support personnel and equipment to safely operate in closer proximity to our antennas than other GP antennas.

Course Structure Total Error Is A Function Of The Static Error And Dynamic Errors

$$TE = \sqrt{SE^2 + DE^2}$$

- Installing our EFGS can significantly reduce your Total Error (TE) by reducing the existing Static Error (SE) at your site. Our EFGS also minimizes the Dynamic Error (DE) resulting in smaller critical and sensitive areas.
- End-Fire (EFGS) provides a Static Error improvement of at least 39% over the Null Reference (NR), at least 28% improvement over the Sideband Reference (SBR) and can outperform a Capture-Effect (CE) / M-Array in certain circumstances.
- Additionally, our non-imaging EFGS has a reduced Dynamic error when compared to the Null Reference (NR), Side-Band Reference (SBR), and Capture-Effect (CE) type image GPs.

Additional Course Structure Error Reductions Available From The EFGS

- As stated, the End-Fire provides a Static Error improvement of at least 39% over the Null Reference (NR), at least 28% improvement over the Sideband Reference (SBR) and can outperform a Capture-Effect (CE) / M-Array in certain circumstances.
- If the NR, SBR, or CE site has an imperfect ground plane, you can expect even more performance increase from our EFGS.
- If the NR, SBR, or CE site has lateral reflections (from power lines, buildings, fences or terrain) you can expect even more performance increase from our EFGS.
- Our EFGS permits further optimization of performance through pedestal adjustments. These adjustments are only inherent to EFGS systems.

Need More Reasons To Choose An End-Fire?

Our EFGS system also can:

- Enhance airport operational safety
- Advance GNSS "gate to gate" Performance Based Navigation
- Provide the best available backup landing system to GNSS
- Increase the number of takeoffs and landings per hour
- Shorten landing and takeoff cycles
- Lower runway occupancy times
- Increase ground crew movement flexibility
- Increase airport infrastructure construction options
- Provide an ILS GP where previously considered impossible
- Increase an airport's potential for more runways and taxiways
- Reduce problems associated with transitioning from VFR to IFR

Need More Reasons *(Cont'd)*

- Increase the flying publics satisfaction and airports moral
- Reduce the workload on ATC
- Reduce confusion regarding hold short lines for pilots
- Increased protection of the signal-in-space relied upon by pilots
- Reduce airspace congestion
- Reduce multi-taxi occurrences and flight delays
- Lower carbon emissions
- Lower fuel consumption
- Lower noise volumes and potential for litigation
- Increase airspace resiliency
- Efficiently normalize airspace activity from external disruptions

The Bottom Line

Air travel is expected to dramatically increase over the next few decades and with it will come great financial opportunities for airports and the people in their communities. That is, if they position themselves for growth now. Our Advanced ILS antenna systems automatically position airports for growth and development …

- By mitigating barriers to economic growth and optimization in & around airports.
- By increasing efficiency for all airport operations from ATC to grounds keeping.
- And by providing the last generation ILS you will ever need to ensure resiliency in airspace systems applying GNSS technologies.

Regardless of site, Watts Antenna Company's High-performance Advanced ILS antenna systems will boost your bottom line.

For More Information

Individual links for more complete information on our various EFGS products as well as our Stakeholder's page are provided below for your convenience.

- Model 105 End-Fire
- Model 106 End-Fire
- Model 107 End-Fire
- Stakeholder's Page

We hope that you have found these links and this presentation to be helpful in determining the viability of our EFGS for your sites.

WATTS ANTENNA COMPANY

Please Visit Our Website
For Additional Information

www.wattsantenna.com

Or Contact Us Directly At
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