

NGFMS UPGRADE FOR EMBRAER E-JETS.

EPIC LOAD 27 UPDATE



Honeywell

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LOAD 27/NGFMS UPGRADE: AN INTRODUCTION

1

Introducing the latest EPIC Load 27 Upgrade (Version 27.4) Retrofit for the Next Generation Flight Management System (NGFMS).

Featuring Options and Upgrades including:

- Advanced Runway Awareness and Advisory System (RAAS)
- Synthetic Vision and Integrated Navigation (INAV) with optional charts and maps and more

The EPIC Load 27 upgrade delivers:

- Improved fuel efficiency
- Improved safety
- Reduce direct operating costs
- Reduced pilot workload

The NGFMS for E-Jet aircraft builds on the continuous product improvements seen through the systems integration on the larger B747-400 / B747-8 platforms, delivering improved fuel efficiency, lower direct operating costs, reduced pilot workload and increased safety.

By upgrading with these advanced options, operators of the Embraer E-170 / E-190 E-Jets will be able to take advantage of precision navigation capabilities such as RNP AR approach down to 0.1 RNP and benefit from improved fuel efficiency and performance features delivered by NGFMS. For example, the operator can look forward to 2% reductions in fuel burn per cycle through Cost Indexing/ECON speeds and off-idle descent included in the Gold Option, and further operational efficiencies through reduced track miles flown and fewer missed approaches enabled by RNP AR (at 0.3 RNP in Basic, down to RNP 0.1 on final, and below RNP 1 on missed approach). The LPV approach provides an alternative instrument approach option like ILS with low minimums with availability at non-ILS airports and runways.

The Epic Load 27 Retrofit consists of a required 'Basic' package which replaces the legacy FMS with NGFMS. In addition to the Basic package, several add-ons and software-enabled options can be enabled to deliver additional features and value to the operator.

The Pentium M hardware upgrade is a prerequisite for Epic Load 27 Basic and all options. The hardware upgrade involves the replacement of the Actuator Input-Output Processor (AIOP) modules, the Air Management Module (AMM), the Central Maintenance Computer (CMC), switching the Network Interface Card/Processor (NIC/PROC) with the new cards to upgrade the processor to Intel Pentium M. Incentive pricing for the Pentium M upgrade has been established for operators that chose the Epic load 27 retrofit concurrently with the Pentium M upgrade.

Approval:

The Load 27 (version 27.4 current at the writing of this bulletin) NGFMS retrofit originally certified in July of 2016.

Aircraft:

Embraer E170/175 & E190/195.

2023 Pricing:

Pricing reflected in this document is 2023 Honeywell Operator pricing valid through December 2023.

Installation of hardware and software outlined in this brochure requires Embraer Service Bulletin which is not included in the pricing. Contact Embraer for price and schedule for required installation documentation.

Other Load 27 functionalities have additional aircraft equipment prerequisites that must be installed prior to their enablement with the Epic Load 27 retrofit:

- The Low RNP AR Approach and LPV Approach options require the aircraft be equipped with the SBAS-capable GPS modules and antennas.
- The Integrated FANS 2 CPDLC options in Epic Load 27 require enablement of CMF1 and the installation of a third VDL Mode II-capable VDR.
- SVS/INAV require the Display Unit Hardware 3 (DU-1080 HW3 PN 7036340-803) displays in **all five** forward display positions.

The Load 27 NGFMS Basic and Options retrofits, along with prerequisite hardware upgrades described in this bulletin, are available now via Embraer Service Bulletins. Please contact Embraer or Honeywell for further information on the Load 27 NGFMS Basic, Options and Advanced Services upgrades for the Embraer E-Jet and how it can make your fleet more efficient while enabling the capabilities needed to maximize the benefits of next-generation airspace worldwide.



Embraer Service Bulletin Availability

All the Basic and Advanced features described in this bulletin require an Embraer Service Bulletin prior to installation. The Embraer Service Bulletin for Load 27 is tailored for each operator's fleet requiring development time from Embraer's technical services group.

NGFMS UPGRADE PACKAGES – PRICING

| Hardware or Software | Description | Operator List Price per Aircraft (US\$) | Notes |
|---|---|---|---|
| Pentium M Upgrade in conjunction with Load 27.2+/NGFMS. (Required for Load 27 retrofit, NGFMS and Advanced Options) | Provides upgraded processor and memory resources for Load 27.2+/NGFMS and future Epic Loads for the E-Jet. | \$71,119 | |
| Load 27.2+ with Basic NGFMS | Entry-level Load 27.1 Upgrade consisting of NGFMS Basic, required for all Load 27.1 options outlined below. | \$22,824 | <i>NGFMS Basic is required as a prerequisite for ALL options outlined herein.</i> |
| Gold Option | Package of Airline-specific operational efficiency features: Cost Index and ECON speeds, Off-idle descent, and automated landing speeds calculation. | \$65,531 | |
| Advanced RNP Option | Extends Basic RNP AR functionality to enable RNP AR operations below 0.3 RNP on final/ below RNP 1 on Missed Approach. | \$17,743 | <i>Enablement of this feature requires that the aircraft have the SBAS GPS modules previously installed, and is not included in the option price.</i> |
| LPV Approach Option | Adds the ability to select and fly Localizer Performance with Vertical Guidance (LPV/ APV) instrument approach procedures in North America (WAAS LPV) and Europe. | \$57,971 | <i>Enablement of this feature requires that the aircraft have the SBAS GPS modules previously installed, and is not included in the option price.</i> |

LOAD 27/NGFMS UPGRADE: THE BENEFITS

2

The NGFMS Load 27 baseline upgrade offers airlines some specific features that add operational efficiency capabilities that the previous baseline did not provide.

In addition, the Advanced Services features such as Advanced RAAS, SVS, INAV and Electronic Charts bring new capabilities to the aircraft that enhance its ability to operate in the most challenging environments.

Benefits of the Basic NGFMS Upgrade - Foundational NGFMS Features:

- FMS-managed speeds from takeoff to landing; FMS Speed Intervention feature for temporary managed speed changes
- Multiple secondary flight plans with route copy and swap; full performance predictions on Secondary
- Full DO178B Level B FMS
- Support for all ARINC 424 flight plan leg types
- Table-driven performance model utilizing detailed OEM provided Aero/Engine Models and an improved atmospheric model to provide precise performance predictions for all flight phases
- Closest airports: Display of the 10 closest airports with fuel predictions
- Improvements to the AOC datalink function to include Performance Data Uplink and Reports Downlink functions
- RNP AR Approach at RNP 0.3 on final, RNP 1 on Missed Approach
- Robust roadmap for the future
- Automatic LNAV engagement on TOGA

Additional Benefits of Gold Package Option - Airline Operational Efficiency Features:

- Cost Index and ECON speeds enables the implementation and execution of airline cost reduction strategies, optimizes trade-offs between fuel burn and the time-related direct operating costs
- Optimized idle descent path provides fuel savings through early ToD/reduction from cruise thrust and better speed management avoiding usage of speed brakes and additional thrust
- Automated Landing Speeds calculation

For a detailed description of these features and their value to the Airline Operator, see the Honeywell Whitepaper entitled “NGFMS GOLD FOR EMBRAER EJET” Honeywell literature number C61-1629-000-000.

Additional Benefits of RNP AR < 0.3 RNP Option - Availability of Unlimited RNP AR Approach Operations:

- Extends Basic RNP AR Approach capabilities to AR approach operations below RNP 0.3 on final and missed approach below RNP 1
- Reduced go-around and diversion through availability of lower approach minima associated with low RNP procedures
- Consistent attainment of stable approach parameters with the vertical and lateral coupling provided by flying RNP AR procedures

For a detailed description of these features and their value to the Airline Operator, see the Honeywell Whitepaper entitled “UNDERSTANDING PBN, RNAV AND RNP OPERATIONS AND THEIR BENEFITS TO AIRLINE OPERATORS” Honeywell literature number C61-1630-000-000.

Additional Benefits of LPV Approach Option

Like an ILS, but with several distinct advantages and added flexibility:

- From a pilot’s viewpoint, an LPV approach looks and flies like an ILS, but the LPV approach is more stable than ILS as the vertical guidance is not provided via RF technology and therefore not as susceptible to interference
- The LPV approach glide slope is based on the SBAS GPS-based altitude versus the barometric altimeter which is subject to variations due to extreme temperatures or pilot error in the setting of the aircraft altimeter to the field pressure prior to approach
- There are over 3,000 published LPV Approaches in the U.S. LPV Approaches can be easily added to runways that have traditionally not been the runway of choice for IFR operations, providing the lowest minima on alternate runways that are preferable for current winds or other criteria

For a detailed description of these features and their value to the Airline Operator, see the Honeywell Whitepaper entitled “THE BENEFITS OF LPV APPROACH OPERATIONS FOR THE AIRLINE OPERATOR” Honeywell literature number C61-1631-000-000.

NGFMS-Integrated FANS 2 Option

NGFMS hosts both ATN (also known as PM-CPDLC, or Link 2000+) and FANS1/A applications as an integrated system. This system provides a seamless operation to sequence between ATN and FANS1/A regions without required intervention of the crew.

This seamless operation extends to the integration of the message logs and handling of messaging. This system provides ATN CM and PM-CPDLC, as well as FANS1/A AFN, ADS-C, and CPDLC. The FMS-integrated implementation in NGFMS offers several distinct advantages over earlier versions of CPDLC:

- Seamless datalink operation for the crew with significantly improved user experience.
- Integration with the FMS for streamlined loading capability for full route clearance, offset, Required Time of Arrival (RTA) procedures, direct-to clearances and holds.
- Performs validity checks of format/range and Navigation Database lookup of uplink and downlink data through message sharing with FMS which fully leverages the FMS access to the Navigation Database and other logic which enables directly-loadable objects from datalink to the FMS.
- Support for next-generation functionality including uplink of RTA/downlink of EPP as required for 4D TBO operations.

Legacy standalone solutions, such as the PM CPDLC implementation available prior to Load 27.X that have the ATS ATN B1 ATC communications function in the CMF are limited due to the fact that the CMF and FMS are implemented as separate entities with no ability to directly share and operate on messages received via datalink. For example, in the legacy PM-CPDLC implementation, the CMF has no ability to verify received data against the Navigation Database which is solely accessible by the FMS.

By moving the ATS ATN B1 ATC communications function to the FMS, resulting in an FMS-integrated implementation, the function now integrated with FMS has full access to the FMS format/range and navigation database checking capability that is necessary for validating uplink clearances to aircraft via CPDLC. The capability to do so in ATN B2 is foundational to the airspace modernization efforts underway across the globe.

The Load 27.1 Full FANS 2 is the best solution for current and future CPDLC requirements of E-Jet operators and fully meets the European PM CPDLC mandate.

For aircraft that were not enabled for standalone PM CPDLC available with Load 25, the table below outlines the Honeywell-supplied upgrades required to enable the NGFMS-Integrated FANS 2 option, and the associated Honeywell pricing for hardware (when necessary) and APM. The Embraer Service Bulletin and other charges are not included. The Customer must contact Embraer to determine Embraer charges per configuration to obtain complete pricing:

| NGFMS-INTEGRATED FANS 2 UPGRADE – PRICING (US\$) | | | | | |
|---|-------------|-----------------------------------|----------|-----------------------------|--|
| Current Configuration | Add 3rd VDR | Upgrade 3rd VDR to Mode II (-803) | Add CMF | NGFMS-Integrated FANS 2 APM | Total 2023 Honeywell Price for NGFMS-Integrated FANS 2 |
| No 3rd VDR, no CMF | \$38,750 | NA | \$33,162 | \$34,808 | \$106,720 |
| Existing 3rd VDR with no data enabled, no CMF | NA | \$16,580 | \$33,162 | \$34,808 | \$84,550 |
| Existing 3rd VDR Mode A, single CMF | NA | \$16,580 | NA | \$34,808 | \$51,388 |
| Existing 3rd VDR Mode II, single CMF | NA | NA | NA | \\$34,808 | \$34,808 |

Aircraft that were enabled for the standalone PM CPDLC solution available with Load 25 that have been upgraded to Load 27 NGFMS Basic can enable the NGFMS-Integrated FANS 2 option for a reduced APM charge of \$10,711.

ADVANCED FEATURES: ADVANCED RUNWAY AWARENESS AND ADVISORY SYSTEM (RAAS)

3

As an option, Load 27 includes the next generation of Honeywell's Runway Awareness and Advisory System (RAAS) which has proven its value as a runway safety system on many aircraft types from the E170/190 to the larger airline transport platforms.

Advanced RAAS has significant improvements over its predecessor, the RAAS introduced in Load 25.x and certified in 2007. The SmartRunway component of Load 27.1 and subsequent versions was released in 2015 after several years of development. The improved SmartRunway functionality is centered on improvements to the runway incursion prevention capability incorporating the significant field experience gained since the initial certification in 2007.

Another key safety issue and NTSB concern is energy management, maintenance of stabilized approach parameters and awareness of required landing distances with appropriate safety margins when proceeding with a landing when a go-around would be the better course of action. Recent accidents have highlighted the continuing cost of runway excursion. Runway excursions represent 96% of the total runway-related accidents, with 80% of runway excursions resulting in fatalities.

Data from regulators has found that runway excursions, while less frequent than incursions addressed by the original RAAS and SmartRunway, lead to over US\$900 million in damages to the industry annually. Globally, there are approximately 30 runway excursion incidents per year, primarily caused by delayed acknowledgement and correction of out-of-limits parameters, or timely execution of a go around. These causes of runway excursions are the key areas addressed with the Advanced SmartRunway option through the addition of key components of Honeywell SmartLanding functionality in Advanced RAAS.

Runway excursions are typically preceded by unstable approach characteristics such as inappropriate energy management on final approach, aircraft late to landing configuration, aircraft being flown above desired approach path or at too high an airspeed or sink rate.

The Advanced RAAS option provides significant improvements in runway safety and reduces the risk of runway excursions by early identification and crew alerting of an unstable approach via the SmartLanding functionality added to it in load 27.1 and greater. Advanced RAAS therefore encourages crew compliance with the airline’s stable approach Standard Operating Procedures utilizing the Stable Approach Monitor, providing crew alerting when the following standard criteria are not achieved:

- Stable approach parameters (deviation relative to glide path and speed) should be achieved by 1000 feet above the runway threshold.
- If stable approach is not achieved by 500 feet above runway threshold, go around alert is activated
- Proper check of aircraft configuration, gear and flaps, aircraft is configured for landing

Under normal conditions, when correct configuration and stable approach parameters are maintained, no advisories to the crew, aural or visual, are made by the system. If the aircraft approaches the runway too fast or too high indicating improper energy management, an aural callout and visual advisory will be issued. The Stable Approach Monitor uses GPS position, approach speed, the approach angle as well as the runway position data from the Honeywell Terrain Database to assess the stability of each approach.

Pricing for the enablement of the Advanced RAAS function as part of the Load 27 upgrade is dependent on the aircraft configuration at the time of upgrade to Load 27. For aircraft with earlier versions of RAAS available with Load 25 there is a reduced upgrade price that is all inclusive. For those that currently have no RAAS functionality enabled and are adding Advanced RAAS as part of a Load 27 upgrade, the Honeywell portion is provided in the table below, and Embraer must be contacted for Service Bulletin pricing. Current Operator pricing for Advanced RAAS is outlined in the table below:

| ADVANCED RAAS – PRICING | | |
|--------------------------------|--|--|
| Current Configuration | Enable Load 27 Advanced RAAS per tail | Notes |
| Previous RAAS version enabled | \$10,711 | Existing APM on aircraft must have RAAS enabled. |
| No RAAS functionality enabled | \$26,776 | New Enablement of Advanced RAAS with Load 27 Basic |

ADVANCED FEATURES: SVS (SMARTVIEW)[™]/INAV[™]

The advanced features available with Load 27 include options that add even greater value to the E-Jet operator by taking full advantage of Honeywell's next-generation displays technologies.

In addition to the Pentium M which is required for Load 27, the Advanced Services outlined in this section require the aircraft have the latest display hardware revision, Display Unit Hardware 3 (DU-1080), on all five of the forward displays as a prerequisite to enabling this functionality. These display units have been added to the aircraft IPC, so the pricing in the table below is all-inclusive for the required display upgrade on aircraft, no additional Service Bulletin is required.

SmartView[™] - Honeywell's Synthetic Vision System (SVS) dramatically improves Situational Awareness through the modification of the PFD from traditional "blue over brown" attitude indicators to a rendered representation of both the aircraft state (e.g., aircraft attitude, speed, altitude and vertical speed trends using HUD symbology) and its' current situational environment including nearby terrain and the airport environment when in the terminal area.

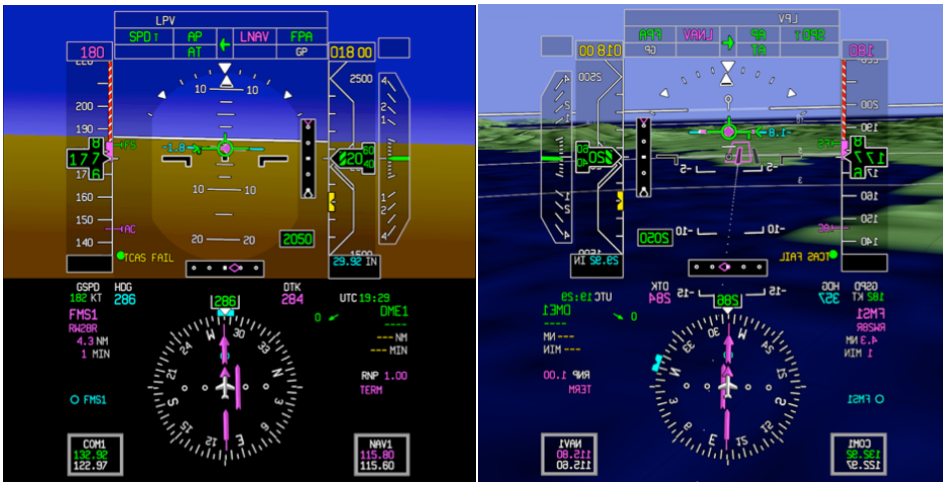
SmartView synthesizes flight information from multiple onboard databases, GPS and inertial reference systems into a complete, easy-to-understand 3-D rendering of the forward terrain. Its unparalleled resolution provides a view that pilots would otherwise only see on a clear day.

With a realistic view of surroundings day or night, whatever the weather, SmartView eases pilots' workload and gives them more confidence in difficult conditions.

Benefits include:

- Increased safety
- Improved situational awareness
- Reduced pilot workload
- Reduced technical flight errors
- Enhanced operational flexibility
- Eliminates poor visibility as a safety factor
- Simplified instrument flying
- Utilizes advanced head-up display (HUD) symbology
- Displays terrain database perspective
- Uses color coding for absolute altitude terrain
- Provides visualization of obstacles
- Depicts airport and runway environment including extended course centerline
- Displays unusual attitude declutter logic

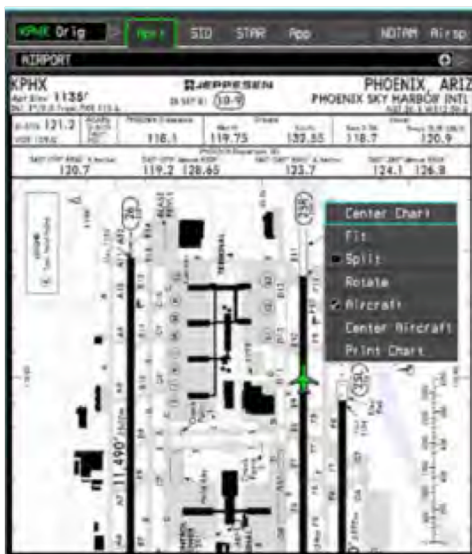
The following illustration shows a side-by-side comparison of the standard E-Jet PFD on the left, and the SVS PFD on the right, during a flight at almost the same point in time. Note that with the SVS display the terrain and airport features are rendered synthetically to provide the crew with unparalleled situational awareness via the PFD regardless of actual ceiling and visibility conditions, especially in the terminal area:



In addition to SVS, enablement of this option also enables the Integrated Navigation (INAV) functionality for the MFD moving map display. As shown in the figure below, the INAV functionality enhances the crew's navigational situational awareness through depictions of the lateral flight plan enhanced with a moving map, and vertically via the Vertical Situation Display (VSD) and provides new options for the crew to interact and view the flight plan graphically vs textually:



As an additional option to the SVS/INAV functionality, electronic charts and maps may be enabled as well. This functionality enables the rendering of an electronic image of charts such as Airport Diagrams, Instrument Approach Procedures (IAPs), Standard Instrument Departures (SIDs) and Standard Terminal Arrival Route (STARs) and maps such as Instrument Flight Rules charts. These are shown on a forward display and include a continuously updating own ship position. Enabling this feature allows the NavDB and the Echarts to be updated in the same operation on the aircraft so that there is always an up-to-date version available on the forward display and allows the EFB to be used for other purposes during the flight while maintaining superior situational awareness.



With E-Charts and Maps Enabled, Airport Diagrams and other Charts can be displayed in the crew's forward field of view, with a continuously updating own ship position shown on the chart.

The following table outlines the pricing of the Advanced Features flight displays options:

| FLIGHT DISPLAYS ADVANCED FEATURES – PRICING | | | |
|---|--|---|--|
| Hardware or Software | Description | Operator List Price per Aircraft (US\$) | Notes |
| Display Unit Hardware 3 (DU-1080) Part Number 7036340-803 | Upgraded display performance and capacity required for all Advanced Features described in this section. Requires all 5 forward displays be at this revision. | Contact Honeywell Sales Rep for current pricing | 5 DUs per aircraft (no Embraer SB required, new DU is added to IPC as an alternate part. Verify IPC, contact Embraer if not reflected as alternate part) |
| SVS (SmartView™) / INAV™ / Graphical Flight Planning ¹ | Synthetic Vision System PFD, Integrated Navigation with Graphical Flight Planning | \$65,333 | Requires all 5 DUs at HW3 revision -- see above |
| Electronic Charts and Maps | Electronic Charts and Maps with own ship position on MFD | \$28,917 | Requires all 5 DUs at HW3 revision -- see above |

HONEYWELL **ORDERING PROCESS**

5

Complete instructions and other guidance for ordering the Honeywell components necessary for installation and configuration of Load 27, hardware, software and APM can be found in the following SIL available in the Technical Publications accessible from MyAerospace.com. Simply search Technical Publications for the following publication number (Load 27.4): Publication Number D202105001786.

PILOT DOCUMENTATION AND TRAINING FOR LOAD 27

6

Embraer and Honeywell have several documents and videos available for pilot training on the Load 27 NGFMS features:

The Embraer Load 27 NGFMS documentation includes the following:

1. TG-6093 NGFMS Transition Guide
2. AFM new supplement 4
3. ACFOG new section 2
4. SOPM
5. GP-5990 RNP AR NGFMS

There is an Embraer training video on differences (requires a FlyEmbraer account that has been enabled by the Company Administrator for access to the Flight Operations "Videos" folder):

NGFMS Training OV-170/037 NGFMS Differences

Authorized users can connect directly via this link:

<http://goo.gl/aOD1ci>

The following Honeywell documentation can be found on the MyAerospace.com Portal (requires an account with the Technical Publications application enabled – search on publication number):

1. Load 27 FMS Pilots Guide (*Publication D201007000016*)
2. Description of Crew Impact Changes for the Embraer 170/175/190/195 Load 27.1, Pilot Familiarization Guide (*Publication D201009000038*)
3. Primus Epic AV / NGFMS Operational Overview of the Embraer 170/175/190/195 Pilot Familiarization Guide, Load 27 (*Publication D201505000051*)

In addition, Honeywell has published several NGFMS-specific training videos on YouTube that cover specific features or functionality of NGFMS. Note that some of these videos specifically reference the E2, however NGFMS functionality is essentially equivalent:

- FMS Basic Flight Planning – Performance Initialization
<https://youtu.be/4DkyHGUjNEM>
- FMS Basic Flight Planning – Takeoff Init & Performance Data
https://youtu.be/j2bkZ_EJvz8
- FMS Basic Flight Planning – Landing Initialization
<https://youtu.be/MFXq35w6f6s>
- FMS Basic Flight Planning – Enroute Operations Part 1 on the Embraer
<https://youtu.be/7tQx2X0s7lg6>
- NGFMS Secondary Flight planning
<https://youtu.be/ab3S1kLaEiA>
- FMS Basic Flight Planning – Entering Waypoints
<https://youtu.be/v6DGOZQkQec>
- FMS Basic Flight Planning – Temporary Waypoints
<https://youtu.be/jl6cmcdqFs>
- FMS Advanced Flight Planning – Temperature Compensation Technique
https://youtu.be/nOOHPrf_9k8
- LPV Approach
<https://youtu.be/RdJyNyLaW98>
- SmartLanding & SmartRunway
<https://youtu.be/fqYbdgYFLv8>

For More Information

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