JAPAN’S ACTION PLAN

To Reduce Greenhouse Gas Emissions From Aviation
Japan’s Action Plan to Reduce Greenhouse Gas Emissions from Aviation

**Executive Summary**

Recognizing the importance of the global warming issue, Japan has been sincerely making aggressive efforts to address Greenhouse Gas (GHG) Emissions from Aviation. Japan has been taking a wide range of possible measures in various fields in aviation, including air traffic management improvements and airport initiatives as well as aircraft emission reduction measures.

The volume of CO2 emissions from Japan’s domestic and international aviation activities in 2013 was 21.65M tonnes, increase by 22% compared to that of 2005. This fact shows that Japan took the goals of the 2012 Action Plan seriously and made active efforts to improve aviation fuel efficiency accordingly.

In 2013, Japan’s domestic aviation sector achieved a 7.7% improvement in fuel efficiency compared with 2005. In 2013, Japan’s international aviation sector achieved a 20.7% improvement in fuel efficiency compared with 2005.

Judging from the technical measures which Japan has taken so far, currently continues to take, and will possibly take in the future, Japan will continue to address GHG emissions reduction from the aviation sector to achieve an average of 1.5% year-on-year improvement in fuel efficiency by 2020, as compared with the 2005 baseline, in both domestic and international operations.

In order to attain such fuel efficiency improvements, Japan will take various measures that include:

- Promoting the introduction of fuel-efficient aircraft;
- Sustaining fuel-efficient performance by conducting adequate maintenance;
- Operational improvement; and
- Emission reduction measures during parking on the ground.

Japan will make further efforts to achieve an average of 2.0% year-on-year improvement in fuel efficiency by 2020, as compared with the 2005 baseline, implementing additional
emission reduction measures, if such measures become technically available in the future.

Meanwhile, regarding GHG emissions reduction beyond 2020, Japan will continue to make technical efforts and implement realizable measures aiming for improving fuel efficiency by 25% by 2030 compared to that of the 2005 baseline.

Some examples of future measures and efforts, which are expected to contribute to improving fuel efficiency and reducing emissions from aviation, include:

- Improvement of air traffic systems and relevant research and development;
- Promotion of alternative fuels; and
- Global Market Based Measure (GMBM) for international aviation

1. Achievements and Experiences

Recognizing the importance of the global warming issue, Japan has been sincerely making active efforts to address GHG emissions reduction from the aviation sector. Japan has been taking wide range of measures in various fields of aviation including air traffic management improvements and airport initiatives as well as aircraft emission reduction measures.

- The government of Japan and the Japanese aviation industry have been taking measures which contribute to reducing GHG emissions from aviation and improving aviation fuel efficiency in Japan.
  - Japanese air carriers have introduced fuel-efficient aircrafts and have been conducting fuel-efficient operations.
The two largest Japanese air carriers, All Nippon Airways (ANA) and Japan Airlines (JAL) committed themselves in 2008 and 2010 respectively to environmental protection including GHG emissions reduction based on the government-led ‘Eco-First’ Program. In this respect, ANA has set its goal to reduce the annual CO2 emissions from domestic air services from 2012 to 2020 to 4.4M tonnes or less on average and reduce CO2 emissions per domestic/international revenue tonne kilometer (RTK) by 20% compared to that of 2005. Meanwhile, JAL has set its goal to reduce CO2 emissions per domestic/international RTK by 23% by 2020 compared to that of 2005. This fact shows that these Japanese air carriers are actively committed to GHG emissions reduction.

“ECO-FIRST Program”
The Eco-First Program was started in April 2008 by the Ministry of the Environment. It is a program whereby companies give the Minister of the Environment their voluntary commitments that they will pursue environmental initiatives to lead industries, taking measures to prevent global warming or protect biodiversities.

- Japan Civil Aviation Bureau (JCAB) has supported the improvement of fuel efficiency as well as safety enhancements through the improvement of air traffic systems. JCAB developed the RNAV (aRea Navigation) roadmap, and started deployment of RNAV routes which are expected to shorten flight distances in 2007, and completed full implementation of main city pairs in 2011, except oceanic areas.
JCAB has been implementing Air Traffic Flow Management (ATFM) since 1994, and endeavors to maintain maximum and appropriate traffic flow. In case the volume of traffic is expected to overflow its air space capacity, an air traffic management officer will assign appropriate taking-off times to departing aircraft and/or will assign separation or time to enter a congested air space to in-flight aircraft.

- Japanese airports have improved their own facilities and equipment and supported flight operations which contribute to reducing GHG emissions from aircraft.

Japan has a long history of providing Ground Power Unit (GPU) services, with the first GPU (fixed type) introduced in 1967. Currently 13 Japanese airports provide GPU (fixed type) services. They contribute to reducing the use of aircraft Auxiliary Power Units (APUs) at gates. Introducing electrical vehicles and low emission vehicles for ground support would also lead to reduce GHG emissions from ground support equipment.

Another example is that New Chitose Airport has been promoting the “Cool Project”, using removed snow from airport and stored for air conditioning of the terminals for summer period. CO2 emissions are being reduced by switching from fossil-fuel based energy to the utilization of snow and ice as a natural source of cold energy.

Most of the measures above in Japanese airports have been voluntarily taken, collaborating with stakeholders, according to their own characteristics respectively by airport authorities and parties concerned. They have developed airport environment plans voluntarily based on the concept of sustainable growth. JCAB has established “Eco-Airport
Japan’s Action Plan


- Japan’s CO2 emissions from domestic/international aviation have decreased by 22% in 2013 compared to that of 2005. To achieve this, Japan has been actively taking measures to improve aviation fuel efficiency in both domestic/international aviation through government-industry cooperation.
  - In 2013, Japan’s domestic aviation achieved a 7.7% improvement in fuel efficiency compared with 2005. Also in 2013, Japan’s international aviation achieved a 20.7% improvement in fuel efficiency compared with 2005.

2. Japan’s Aspirational Goals for Aviation Emission Reduction

- Judging from the technical measures which Japan has taken so far, continues to take, and will possibly take in the future, Japan continues to address GHG emissions reduction from the aviation sector to achieve an average of 1.5% year-on-year improvement in fuel efficiency by 2020, as compared with the 2005 baseline, in both domestic and international operations.
- In order to attain such fuel efficiency improvements, Japan will take various measures that include:
  - Promoting the introduction of fuel-efficient aircraft;
  - Sustaining fuel-efficient performance by conducting adequate maintenance;
  - Operational improvement; and
  - Emission reduction measures during parking on the ground.
- Japan will make further efforts to achieve an average of 2.0% year-on-year improvement by 2020, as compared with the 2005 baseline, implementing additional emission reduction measures, if such measures become technically available in the future.
  - For example, JCAB will reduce CO2 by upgrading air traffic systems, i.e. by realizing the long-term vision CARATS (Collaborative Actions for
Renovation of Air Traffic System), focusing on air traffic management (ATM) to optimize the trajectory from departure to arrival.

- Also, Japan aims to reduce CO2 emissions by promoting the use of sustainable alternative fuels, which are expected to reduce emissions on a global scale.

- To achieve Japan’s aspirational goals, there are additional considerations that include:
  - Japanese air carriers will continue to aggressively introduce new generation aircrafts and to effectively use them. To ensure that such measures would consistently contribute to improving fuel efficiency, newly-manufactured aircraft need to be delivered on schedule. In case that delivery of newly-manufactured aircraft would be delayed due to problems in the production process, improvement in fuel efficiency could also be delayed; and
  - Without having harmonious relationship with the ICAO Member States concerned or cooperation from the aviation industry, a comprehensive improvement in fuel efficiency cannot be achieved, even though an efficient flight procedure can be realized across Japan. In other words, even if all Japanese air carriers would be ready to use infrastructure and systems have already been implemented across Japan, effects on flight efficiency might be limited unless foreign air carriers take the same measures.
  - A task force (Alternative Fuels Task Force : AFTF) consisting of alternative aviation fuel experts has been formed under ICAO Committee on Aviation Environmental Protection (CAEP), and life cycle assessment and future demand projection in alternative aviation fuel are currently being studied. Hence, Japan will work out the details based on these results.

- As for 2020 and beyond, Japan will make efforts to improve fuel efficiency by 25% compared with that of the base year 2005.

- Regarding the goals in 2020 and beyond, Japan deems it necessary to review the goals taking into the consideration the ICAO Global Aspirational
Goals and the recommendations about the GMBM which is to be submitted to the 39th ICAO Assembly in 2016.

- Based on the latest Japan’s aviation demand forecast and above potential measures, RTK and CO2 emissions up to 2030 from domestic /international aviation are as follows;
  - The actual RTK in 2010 was 18.837M tonne kilometers and forecasted RTK in 2020 and 2030 are 25,934M tonne kilometers and 34,670M tonne kilometers respectively.
  - The actual CO2 emissions in 2010 was 20.02M tonnes and the estimates for 2020 and 2030 are as follows;
    - Estimates for Baseline (without action) scenario
      2020: 27.05M tonnes, 2030: 36.16M tonnes
    - Estimates for Expected results (with the actions) scenario
  - As for the above CO2 emissions estimates for Baseline (without action) scenario, the numbers are calculated based on the fuel efficiency in 2013, given the fact that Japan has already taken various measures against GHG emissions.
3. Measures to Achieve Goals

- Japan will continue to actively address GHG emissions reduction from aviation. The measures described below, including the ones which have already been implemented, will contribute to the achievement of Japan’s aspirational goals for improving fuel efficiency and reducing aviation emissions.

  - Introduction of New Aircraft
    The most effective way to reduce CO2 emissions from aircraft is to improve its fuel efficiency. Hence, Japanese air carriers intend to replace aged ones with new environmentally friendly light weighted types of aircraft with highly fuel-efficient engines.

  - Winglet Installation
    These are wing tip extensions that are expected to reduce induced drag, contributing to fuel efficiency improvements and CO2 emissions reduction. This measure is useful for older models.

  - Engine Washing
    Repeatedly-used engine compressor blades get dusty, which results in deteriorated fuel efficiency. In order to prevent fuel efficiency from worsening, engine compressors are washed with water on a regular basis to recover engine performance for the enhancement of fuel efficiency.

  - Reducing weight of In-flight Items and Equipment
    Japanese air carriers succeeded in fuel efficiency improvement by lightening in-flight items and equipment. Some examples of weight reduction include; cargo containers of lighter material, reduced amount of potable water, service carts of lighter material, reduced number of in-flight magazines, plates of lighter material, wines in PET bottles, spoons of lighter material, etc.

  - Fuel Saving with Flight Simulators for Flight Crew Training and Check
Using flight simulators for flight crew training and proficiency check within limits bounded by the Civil Aeronautics Act instead of real aircraft contributes to reducing fuel consumption and CO2 emissions.
- Power Reduction of Thrust Reversers for Landing
  While ensuring safety, the use of thrust reversers during landing is reduced as a means to reduce engine output, which in turn reduces both CO2 emissions and noise.

- Taxing after Landing with Partial Engine(s) Shut Down
  Taxing aircraft after landing with the partial engine(s) shutdown may also contribute to reducing CO2 emissions. The decision on whether the engines are to be shut down or not shall be made in a comprehensive manner based on the length of runway, weather conditions, TWY surface condition, aircraft condition, instructions from the control tower, etc.

- Effective Use of Airport Infrastructure
  Aircrafts need electric power for cabin lighting, etc., after arriving at destination airports and engine shutdown. Aircrafts equipped with an APU use the APU to supply electric power for cabin lighting and air conditioning when the engines are shut down while parking at airports. By supplying electric power to aircrafts using GPU which is a part of ground infrastructure instead of APU, reduction of jet fuel consumption and noise could be achieved. Japan will consider installing more GPU at large airports and will raise the GPU usage ratio.

- Utilization of Rapid-exit Taxiway and Bypass Taxiway
  In some Japanese airports, rapid-exit taxiways are being used in order to reduce runway occupancy time of landed aircraft and to allow aircraft to leave the runway at higher speeds. Bypass taxiways are also being used in order to provide aircraft with a smooth flow between a runway and a gate. These taxiways allow aircraft to reduce taxi time after landing or before departure, and contribute to reducing GHG emissions.

- Reducing Emissions from Ground Support Equipment in Airports
Introducing electrical vehicles and low emission vehicles for ground supports would also lead to reduce GHG emissions from ground support equipment.

- Some examples of future measures and efforts, which are expected to contribute to improving fuel efficiency and reducing emissions from aviation include:
  
  - **All Flight Crew Equipped with Portable Terminals**
    
    One of the Japanese air carriers aims to equip all its flight crew with portable terminals. These terminals will enable them in the cockpit to access weather information for navigation, the latest passenger information and cargo information, which were not fully available in the past due to limited access. In particular, it is expected that flight plans could be created with optimal trajectory, resulting in less fuel consumption.

  - **Improvement of Air Traffic Systems and Relevant Research and Development**
    
    JCAB develops advanced air traffic systems for realizing the vision of CARATS and conducts research and development to plan and implement medium-and-long term measures. JCAB shows examples of measures to contribute to CO2 discharge reduction as follows:

    - **Flexible Use of Airspace (FUA)**
      
      JCAB assumes that if no one plans to use training/testing area, civil aircraft can fly across such area after coordinated with the concerned authorities to take a shortcut to flight routes. Therefore, JCAB can provide the short-cut route rather than the routine route, making it possible to reduce fuel consumption.

    - **User Preferred Routes (UPRs)**
      
      UPR is specific flight procedures before departures, which enables air carriers to determine the most fuel efficient route for each navigation, taking into consideration aircraft type/performance, flight schedules, upper wind and bad weather warnings. Fuel consumption reduction is expected.
In 2008, JCAB started to introduce UPRs on Japan-Hawaii routes and now UPRs are implemented on Japan-Oceania routes, Japan-US routes (excl. some West Coast routes) and Japan-Koror route. Japan will consider further UPRs expansion on other routes.

◇ Dynamic Airborne Reroute Procedure (DARP)
DARP is a method allowing the aircraft in-flight to make a change to the optimal trajectory according to the latest weather conditions or air navigation conditions for the purpose of reducing fuel consumption.
In September 2013, JCAB started trial operations of DARP on Japan-Hawaii routes, and will introduce DARP on more routes.

◇ Reducing of Aircraft-spacing
In oceanic airspace, aircraft-spacing can be reduced with the use of Automatic Dependent Surveillance (ADS), maintaining optimal altitude more easily, which results in the reduction of fuel consumption. Currently, vertical/horizontal separation between RNP4 aircraft equipped with ADS is set at 30NM, and JCAB will study further spacing reduction.

◇ PBN (RNAV and RNP)
RNAV is a navigation method which enables the pilot to navigate on any desired flight path by measuring its position with the use of radio waves, including GPS.
Conventional routes were connected by ground-based navigation aids and routes position was dependent on matters such as VORs. With RNAV, route establishment becomes more flexible, as it is no longer constrained by the availability of ground-based navigation aids. This opens the possibility of shortening routes. Thus, RNAV will reduce flight time and improve efficiency, also contributing to the CO2 emissions reduction. JCAB introduced RNAV routes according to the RNAV roadmap from 2007. By 2011, JCAB has shortened flight distances for its domestic 75 routes of main city pairs by 3% of the gross flight lengths. As for Departure and Approach Procedures, JCAB is now promoting the introduction of higher-accuracy Required
Navigation Performance (RNP) in addition to RNAV, and will consider the implementations at other airports.

Continuous Descent Operations (CDO)
CDO are a flight descent procedure that has been optimized so that the aircraft can fly with engines at idle thrust from a high altitude - potentially from cruise - until initial approach fix (IAF). An aircraft executing the CDO can descend more steadily because it does not need to adjust the engine thrust in descending. Thus, CO2 emissions can be reduced accordingly.

The CDO in Japan started for the arrival of Kansai International Airport during late night/early morning hours by Japanese airliners from 2009, and in 2013, the full-fledged CDO started, extending operation hours and covering all the air carriers. In addition to that, in 2013, a trial CDO started at Naha International Airport during late night/early morning hours. CO2 reduction from these operations are 800 tonnes or over per year. JCAB will consider to increase the number of airports to implement CDO based on the evaluation of the current operations.

Advancement of ATFM
Now ATFM is being operated in Japan by specifying EDCT (Expected Departure Clearance Time) and so on.

Additionally in August 2011, a trial operation that air traffic management officers assign the sequencing for flying aircraft and coordinates the time of passing FIX (CFDT: Calculated Fix Departure Time) started at Haneda Airport. This approach is now under evaluation. By implementing this sequence
management, enroute-holdings or excessive radar vectors can be avoided, and thus CO2 emissions will be reduced.

✧ Efficiency of Airport Field Operations

JCAB aims to maximize runway capacity and to reduce CO2 emissions at airports, by improving the prediction accuracy of air traffic management at each flight phase, i.e., at departure, arrival and taxiing, as well as optimizing traffic on airport surfaces and eliminating a congestion of departing aircraft on taxiways. JCAB plans to introduce such measures in a phased manner in order to keep pace with the increase in demand at airports for the Tokyo metropolitan area (Haneda and Narita Airports).

Furthermore, Japan is promoting research and development as follows:

✧ Optimization of Oceanic Track System including Arrival Routes

This study aims to expand operation hours of CDO, which is designed to connect oceanic routes with terminal arrival routes, allowing aircraft to descend from cruise to final approach smoothly.

✧ Study on “Full-4D” Trajectory-based Operations (TBO)

JCAB will carry out a study to control the movements of all aircraft, from its departure to arrival in an integrated manner, to realize the “Full-4D” Trajectory-based Operations (TBO), which provides safe and optimal flight routes with less CO2 emissions.

✧ Study on Advanced Landing Procedures (Precision Approaches along Curved Path utilizing Global Navigation Satellite System (GNSS), etc.)

Currently, precision approaches along straight paths are only available with GNSS, and JCAB will carry out a technical research, including Ground-based Augmentation System (GBAS), in order to realize advanced flight procedures. By implementing such procedures, CO2
emissions are expected to be reduced and air traffic control capacity will be enhanced.

- Light Emitting Diode (LED) for Aeronautical Lights
  Light Emitting Diode (LED) have advantages in low power consumption and long service life compared with existing halogen bulbs. Introducing LED contributes to the reduction of CO2 emissions in the product life cycle.

  Japan has promoted to install LED -type taxiway edge light and taxiway center line light, and will consider the development and implementation of LED Runway lights.

- Promotion of Alternative Fuels in Aviation
  Alternative fuels in aviation are alternative to conventional petroleum-based aviation fuel, which have received considerable attention lately, in terms of reduction of environmental burdens and energy security. In particular, bio jet fuel, among other alternative fuels, is considered to have a large potential to reduce CO2 emissions even on a life cycle basis, including growing process of feedstock. For this reason, the government of Japan will continue to promote the development and use of alternative fuels in aspects of CO2 emissions reduction and energy sustainability.

  - Research and Development
    The New Energy and Industrial Technology Development Organization (NEDO) has been developing basic technologies for biofuel made from biomass raw material such as algae and euglena that does not compete with food, in anticipation of alternating fossil jet fuels in future.

  - Approaches by Japanese Air Carriers
    During the period 2009-2012, Japan’s air carriers, JAL, ANA and NCA conducted test flights using bio-jet fuels for technical validation of aircraft.

    In May 2014, the aviation-related parties established the Initiative for Next-generation Aviation Fuels (INAF) in partnership with the University of Tokyo, the Boeing Company and the companies having
alternative fuel producing technologies or relevant expertise, and have discussions toward the development of frameworks for an alternative fuels supply system in Japan.

✈️ The government of Japan will study the framework for introducing alternative fuels, looking ahead to future plans, towards the 2020 Tokyo Olympics/Paralympics. The study will be conducted in view of the following points;

- The number of flights and selection of airports for the first Introduction
- Development of supply chain and relevant guidelines
- Selection of aircrafts for actual flights
- How to procure alternative fuels and approaches for supplying alternative fuels produced in Japan

The government of Japan and Japanese air carriers will continue to discuss and share information with each other on possibilities, benefits and barriers to develop and use alternative fuels in Japan.

➢ International Cooperation

✈️ Efforts and coordination to address climate change

Member States have discussions towards developing a global framework and standards on aviation and climate change in ICAO. To be specific, ICAO is now working on a GMBM scheme, which is to be submitted to the 39th Assembly in 2016. For this purpose, Environment Advisory Group (EAG) consisted of the ICAO Council States and Global Market-Based Measure Technical Task Force (GMTF) consisted of experts under CAEP were formed to have consultations. In particular, about GMTF activities, the Japanese CAEP member has become one of the five “Chaperones”, and an expert is serving as a Co-Lead for a task assigned to GMTF. Thus,
Japan participates actively in the discussions, and will continue to participate in the worldwide discussions on such agendas.

✧ Asia and Pacific Initiative to Reduce Emissions (ASPIRE)

ASPIRE (Asia and Pacific Initiative to Reduce Emissions) is an ANSPs (Air Navigation Service Providers) collaborative approach to the environmental stewardship of Asia and Pacific aviation by promoting the implementation of operational procedures to reduce fuel consumption and emissions.

The ASPIRE partners, consisting of Airservices Australia, Airways New Zealand, Federal Aviation Administration of the United States, Civil Aviation Bureau of Japan, Civil Aviation Authority of Singapore, and AEROTHAI, are committed to work closely with airlines and other stakeholders in the region in order to communicate and publicize ASPIRE environmental initiatives, goals, progress and performance to the global aviation community, the press and the general public.

✧ CO2 Standard

ICAO CAEP is currently working to develop CO2 certification standard for aircraft, and this standard will be adopted by the CAEP/10 in February 2016. Japan has contributed to the development of a CO2 metric system, and will continue to participate in the activity.

✧ Other Measures

Within the scope of global frameworks and measures to address aviation emissions reduction, Japan will make adequate efforts to reduce aviation emissions in light of discussions on aviation and climate change in ICAO.
4. ICAO Assembly Resolution and Update of States’ Action Plan

- The Assembly Resolution A38-18 in 2013 invites ICAO Member States that choose to prepare or update their action plans to submit them to ICAO by the end of June 2015 and once every three years thereafter.

- Japan will consider to update the Action Plan as necessary within the next three years or so.