Current Situations of Using Drones

- Drones driven by hydrogen fuel cells (“hydrogen drones”) are capable of flying for longer periods of time compared to their battery-mounted equivalents. This advantage is attracting strong demand and expectations for hydrogen drones in such fields as crop-spraying and distribution.
- A hydrogen drone comprises: a fuel cell stack, a hydrogen tank, a hydrogen-supply system (piping, valves, etc.), an air-supply system (a compressor, etc.), propellers and other elements.

Nationality	Company name	Appearance	Flight duration
ROK	MetaVista		11 hours
China	MMC		4 hours
Singapore	HES Energy Systems.		3.5 hours
U.S.	FlightWave		2 hours
Japan	RoboDEX		80 minutes
ROK	DOOSAN		80 minutes
U.K.	Productiv		70 minutes

Compiled by METI based on the information disclosed by each company

Use cases as well as expectations and effects

Field	Current state	Expectations for and effects of hydrogen drones
Crop-spraying	✓ Carrying about 10kg of agricultural chemicals on board ✓ Flying for about 3 to 4 hours per day ✓ Carrying a few dozen batteries ✓ Flying over agricultural fields at an altitude of 10 to 15m	➢ Capable of spraying a large amount of agricultural chemicals for a longer time ➢ No longer needing the carry of or change to spare batteries and expected to improve user-friendliness
Disaster responses (for mountain disasters)	✓ Installing cameras ✓ Flying for about 15 to 20 minutes ✓ Needing to be transported by rescue workers to certain altitudes before starting the operation of drones ✓ Flying at an altitude of about 100m above mountain ranges and other areas	➢ No longer needing costs paid to mountain climbers who transport drones and capable of flying from safe areas such as parking lots at the base of target mountains ➢ Expected to shorten rescue contributing to improving the rate of saving lives
Distribution (for depopulated areas)	✓ Loading such goods as commodities and foods ✓ Needing to meet demand for transporting 10 to 20 goods for a distance of 10 to 20km ✓ Flying over depopulated and other areas at an altitude of 30 to 120m	➢ Capable of transporting a large number of goods over greater distances. ➢ Being expected to enhance the efficiency of distribution and support rescue activities involving commodities and foods during disasters

Source: Excerpts from materials released by the Japan UAV Association and Prodrone Co., Ltd.

Streamlined Overview of Laws and Regulations for Tanks of High Pressure Gas for Storing Hydrogen and Future Directions of Approaches to Such Tanks

- Laws and regulations under the High Pressure Gas Safety Act **stipulate that in transporting or consuming high pressure gas, "companies should not engage in any reckless handling of tanks of high pressure gas in order to not drop or have such tanks fall resulting in causing any impacts on the tanks or damages to valves thereof."**
- **Flying drones with tanks of high pressure gas mounted for storing hydrogen (FPR tanks made of carbon fiber)* at an altitude higher than the predetermined altitude have a high probability of falling due to "reckless handling" taking into consideration the risks associated with the fall of drones (= which is highly likely to violate laws and regulations).**
- Pursuant to the laws and regulations under the High Pressure Gas Safety Act, **companies are required to secure certain conditions and measures in terms of safety** if they intend to fly drones with such mounted tanks at an altitude higher than the predetermined altitude. Against this backdrop, METI **compiled such conditions and measures into guidelines**.

*Note: These tanks refer to those of high pressure gas for storing hydrogen to supply hydrogen to hydrogen fuel cells (hereinafter referred to as the "hydrogen storage tanks").

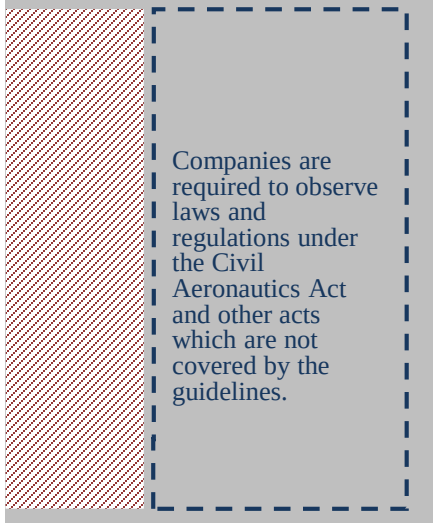
High Pressure Gas Safety Act

Target scope of the guidelines

Scope of operation for which companies are required to acquire a special approval from the METI Minister
Those falling under "reckless handling" of high pressure gas during transportation and consumption
(Note: This requirement of acquiring a special approval may be lifted if a certain amount of data on these operation is accumulated to stipulate common standards and if companies meet these standards.)

Other laws and regulations

✓ Civil Aeronautics Act, etc.



= Among the provisions stipulated in other laws and regulations, companies are required to confirm the provisions in this meshed section for safety assessment pursuant to the laws and regulations under the High Pressure Gas Safety Act.

Outline of the Guidelines

- In accordance with the laws and regulations under the High Pressure Gas Safety Act, companies are required to meet both of the following points before receiving permission for installing hydrogen storage tanks in drones.
  (1) Taking measures and other actions for alleviating impacts on drones that may be caused by the fall of drones (safety of "goods"); and
  (2) Avoiding any acts that may cause impacts on drones (safety of "acts").

- In light of these requirements, METI will examine the safety of drones basically from two perspectives of [i] and [ii] below before issuing a special approval from the METI Minister (to manufacturers and sellers of hydrogen drones as applicants whom METI expects as basic targets).

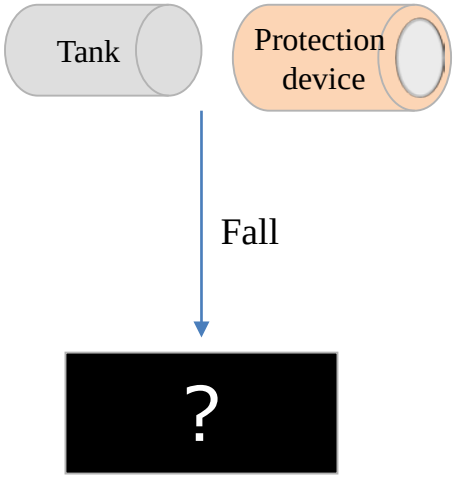
- In receiving a special approval from the METI Minister, **applicants should bear responsibility for users' safe operation of drones** by satisfying such conditions as **"applicants should identify specific users of hydrogen drones in filing a request for receiving a special approval and should not have any persons other than the identified ones operate the drones" and that "applicants should have users of hydrogen drones take training courses for operation."**

<table>
<tr><th colspan="2">[i] Safety of "goods"</th><th>[ii] Safety of "acts"</th></tr>
<tr><td colspan="2">Chapter 1 of the guidelines</td><td>Chapter 2 of the guidelines</td></tr>
<tr><td colspan="2">Requirements that companies should satisfy for receiving a special approval from the METI Minister (= "reckless handling") [ex-ante regulations]</td><td>Requirements that companies should observe in making use of hydrogen drones [ex-post facto regulations]</td></tr>
<tr><td colspan="2">Scope of requirements that manufacturers and sellers of hydrogen drones, e.g., companies manufacturing hydrogen drones, should observe</td><td>Scope of requirements that users of hydrogen drones should observe</td></tr>
<tr><td>According to the places where drones are operated, companies should:
- Take measures to alleviate the impacts on drones caused by a fall;
- Make use of appropriate hydrogen storage tanks and the bodies of drones; etc.</td><td>Companies should secure users' safe operation of drones.
- Identifying users;
- Providing classroom lectures; etc.</td><td>- Keeping the temperature of hydrogen storage tanks at 40 degrees Celsius or less;
- Preventing corrosions of such tanks due to moisture.</td></tr>
</table>

Requirements for Hydrogen Storage Tanks Mounted on Drones

- There is insufficient knowledge on risks in safety in the case where hydrogen storage tanks or their accessories (including those with protection devices) fall to the ground from drones as well as on the adequacy of protection devices to alleviate impacts.
- **Expecting the future need for examinations by METI and the High Pressure Gas Safety Institute of Japan**, the National Institute of Advanced Industrial Science and Technology and the High Pressure Gas Safety Institute of Japan **conducted demonstration tests on assessing risks in safety and the adequacy of protection devices**.
- Specifically, they conducted **[i] impact tests, [ii] cycle tests and [iii] bursting tests**, referring to the details of the tests conducted on hydrogen storage tanks during manufacturing. METI **reflected** the results of these tests as **requirements that should be satisfied on such tanks in the guidelines**.

Current state: Insufficient knowledge on risks in safety caused by a fall and on measures for alleviating impacts



Demonstration tests: Safety of measures for alleviating impacts, which are to be taken, are recognized if these measures satisfy the criteria set in the respective tests.

[i] Impact tests	[ii] Cycle tests	[iii] Bursting tests
Applying to drones the impacts estimated to be caused when the drones fall from 150m above the ground.	Increasing the internal pressure of tanks 1,000 times and confirming whether or not gas leaks from the tanks.	Increasing the internal pressure of tanks and confirming whether or not the tanks burst at a predetermined numerical value of pressure (the minimum burst pressure x 0.9), which is decided per tank.

Requirements that should be satisfied concerning hydrogen storage tanks mounted on drones

Note: Companies are required to dispose tanks, in principle, if drones have fallen to the ground or tanks, etc. have fallen from drones. However, this requirement excludes the case where drones are used under very limited conditions, e.g., demonstration tests in a controlled area, and where safety of tanks is recognized by individual-based examinations.