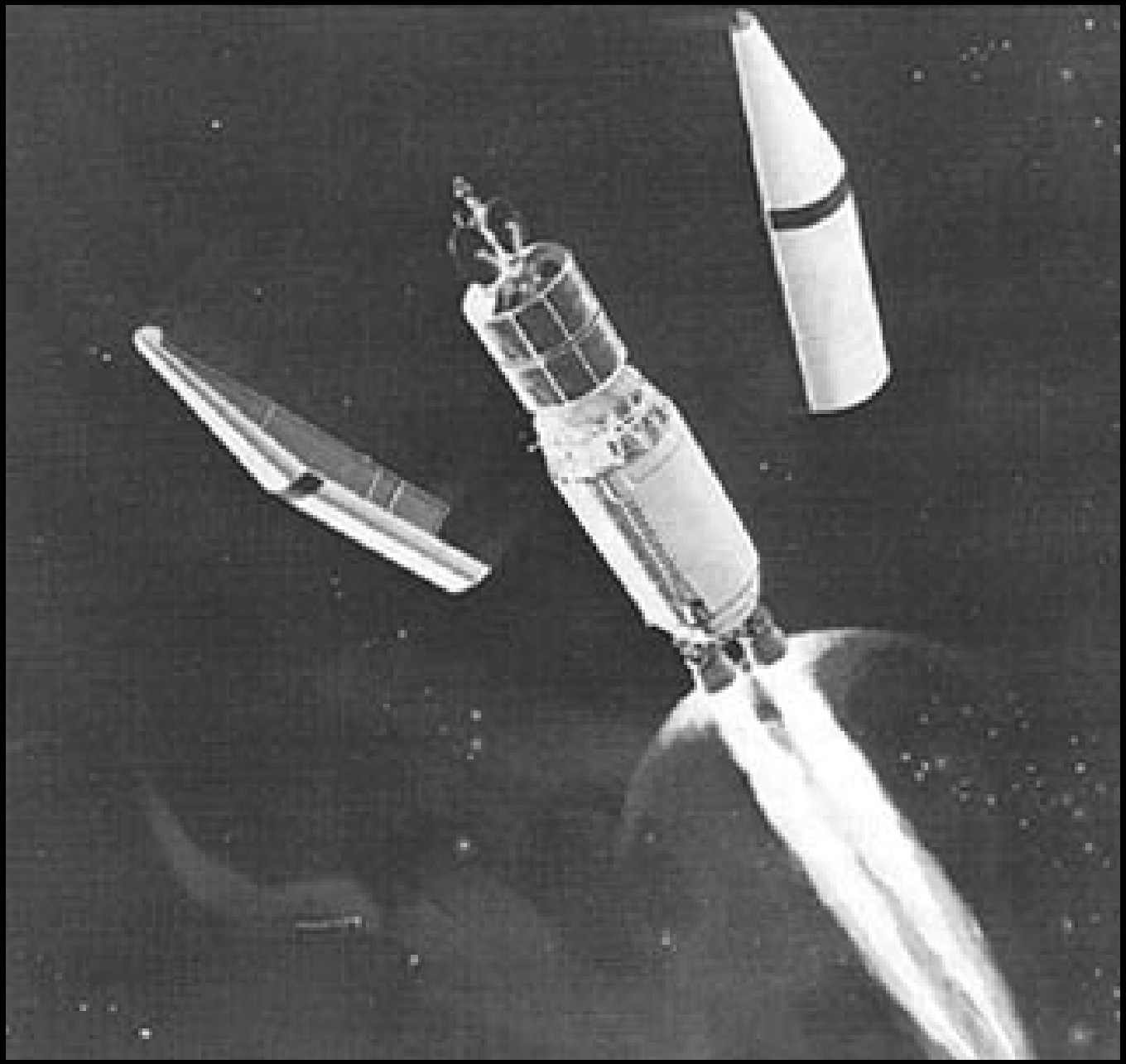
Concerns relating to de facto disposal at sea of jettisoned space-vehicle components

LC/SG 41/8/2

Rocket launches are ‘going up’

- Frequency of commercial space vehicle launches expected to rise substantially in coming decade
- Each launch involves jettisoning of stage 1 and stage 2 booster rockets, plus farings, engine components, batteries and any unburned fuel, in the atmosphere within the first few minutes
- Significant proportion expected to fall to earth…or, more frequently, the sea



Complexity of unburned rocket fuel

Table 1: Types of rocket fuel recorded as being used for commercial space vehicle launches

ammonium perchlorate	liquid natural gas
aluminium powder	lithium batteries
solid hydroxyl-terminated polybutadiene (HTPB)	kerosene
unsymmetrical dimethylhydrazine (UDMH)	high-density white fuming nitric acid
peroxide	turpentine
liquid oxygen	thermoplastic fuel with nanoscale aluminium

Proliferation of commercial launch facilities

- At least 30 active private companies operating or developing space-related launch facilities, based in 12 countries and with launch sites in at least 10 countries.
- Of these, at least nine are on the coast, with the potential for some stages of the launch vehicles to fall into the sea after they are jettisoned.
- In a further 17 cases, it is not specified whether the launch trajectories carry the vehicles over the sea.
- Overview of commercial launch facilities identified to date in LC/SG 41/INF.10…but probably incomplete

e.g. Rocket Lab, New Zealand


ELECTRON

Ministry for the Environment
Manatū Mō Te Taiao

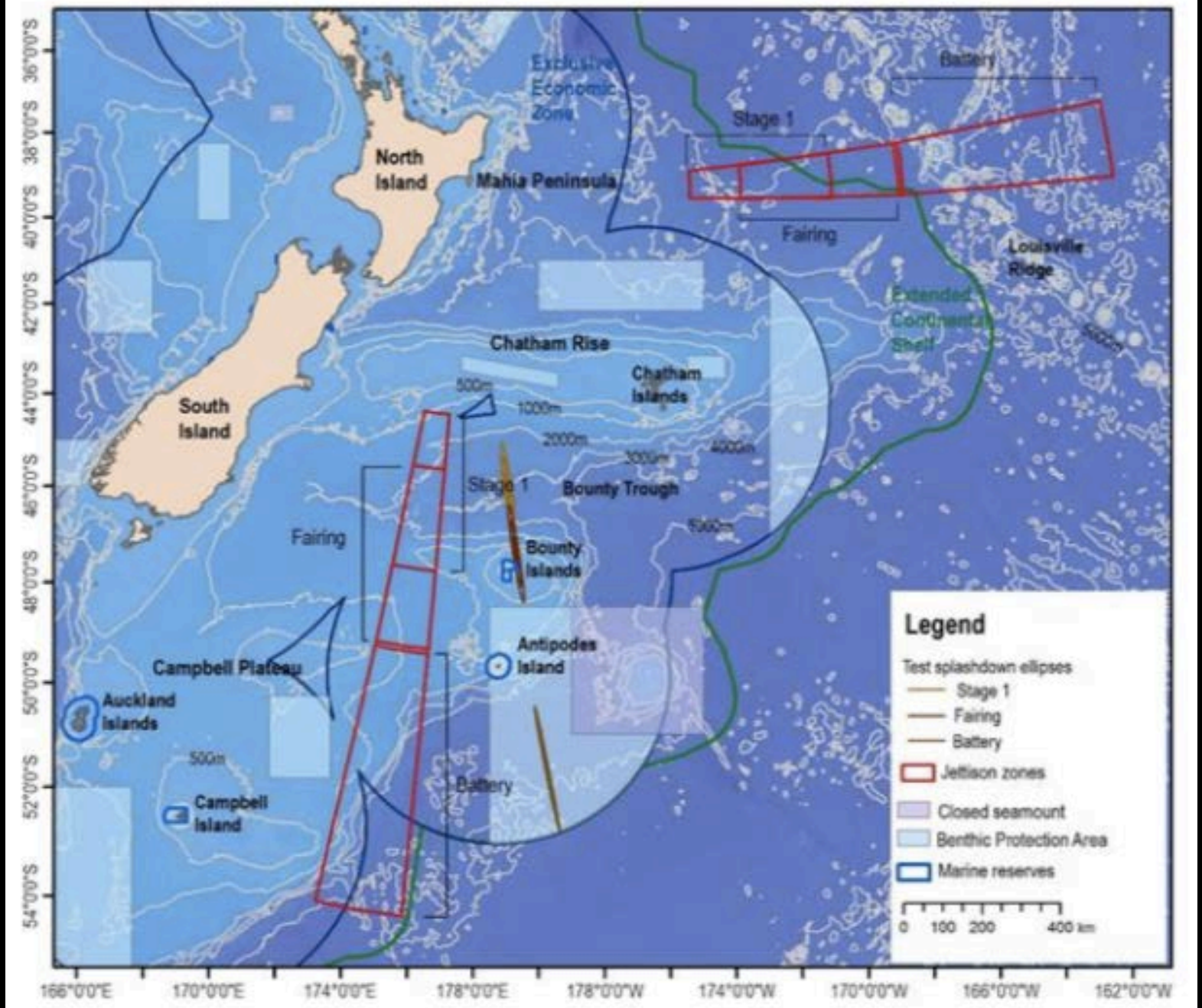
Proposed regulation of jettisoned material from space launch vehicles under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

DISCUSSION DOCUMENT

newzealand.govt.nz

Rocket Lab (NZ) launch statistics

- 3 trial launches in early 2018 – aim for 1 launch per week in longer-term
- 40 t of rocket stage components jettisoned each time - unknown proportion expected to fall uncontrolled into sea
- Stage 1 could still contain several tonnes of kerosene when jettisoned, as well as more than 200 kg of lithium batteries and more than 30 kg of carbon fibre
- NIWA recognises potential for cumulative effects on the seafloor after multiple launches and that there is likely to be some floating debris arising from each launch, potentially dispersed over a wide area
- nonetheless categorized as a "permitted activity", which will require neither a full Environmental Impact Assessment nor any specific marine consent



Source: NIWA. Data supplied by Rocket Lab.

e.g. Rockot/Sentinel launches, Russia

Rockot/Sentinel launch statistics

- Rockot launch vehicle uses unsymmetrical dimethylhydrazine (UDMH) as a fuel, particularly hazardous to humans and the environment
- stage 1 carries up to 71.45 tonnes UDMH, and stage 2, up to 10.71 tonnes
- each stage carries 5-10% excess of total propellant load
- therefore, the two stages may contain as much as eight tonnes of residual UDMH fuel when they are jettisoned

Launch of Sentinel 3B satellite on Rockot launch vehicle from Plesetsk, 25.04.18

- “The first stage of the Rockot booster separated two minutes 16 seconds into the flight at an altitude of more than 68 kilometers in the upper atmosphere.”
- “Then, more than three minutes into the flight, the payload fairing protecting Sentinel-3B split into two halves and fell off.”
- “Both the first stage and the fragments of the payload fairing were expected to fall into the Arctic Ocean between the coast of Norway and Spitsbergen.”

Other commercial launch sites

- Known sites operational or under development in USA, Russia, Australia, Japan, Mexico, French Guiana and Spain (Canary Islands)
- In most cases, little or no information publicly available on expected launch frequency, trajectories, fuels, jettisoned components or environmental impact assessments

Conclusions

- Jettisoned components of space launch vehicles are in essence little different from aircraft…and for aircraft, extensive clean-up, detailed assessment and permitting would be required before allowing disposal at sea
- Commercial launches are expected to increase greatly in frequency in coming years…yet so far there is no consistency in regulatory oversight or control and little transparency

Conclusions

- Lack of publicly available information on the types of engines and fuels used and the quantities and hazards of the materials expected to be jettisoned fundamentally limits any independent assessment of impacts
- Despite being an industry of rapid technological development, most space vehicle launches continue to rely on waste disposal practices from the last century
- Sea disposal of jettisoned components is still considered industry ‘best practice’, with little recovery, recycling or reuse

Action requested of the Scientific Groups

- The Scientific Groups are invited:
  - to take note of the information provided,
  - to comment as they deem appropriate and
  - to consider the need to share further information on this issue with a view to enabling a more comprehensive overview and assessment to be prepared in due course.