Risk analysis of RC jet flying at NZTO

Introduction:

The flying of RC models, and in particular, jet-powered RC models is a fun recreational activity that carries with it a degree of risk. Due to the nature of jet-powered RC model aircraft, this risk is significantly higher than for the more commonly flown models such as usually found at model-flying fields.

This document addresses the risks that are inherent with flying these models at the Tokoroa Airfield (NZTO) and speaks to the risk-factors and consequences associated with this activity.
Foreword

The flying of RC jets has been taking place at Tokoroa Airfield for the past 10 years or so but has not been without incident and it could be that luck is the only factor which as prevented major property damage and/or injury to person or persons.

Of all the activities undertaken at the Tokoroa Airfield, the flying of RC Jets carries the highest risk, due to the proven lack of skill and knowledge exhibited by some of the fliers and the severity of the outcomes which can result from incidents involving these craft.

Hazards associated with turbine-powered RC models:

- ballistic effects
- explosive effects
- incendiary effects
- toxicity effects

Quantifying the consequences of RC jet crashes

Ballistic effects:
The average jet-powered RC model weighs between 10Kg and 20Kg and has a flight-speed of between 160kph and 320kph. This results in a total kinetic energy of between 10K Joules and 80K Joules, or over 90 times as much energy as a 357 magnum bullet when fired from a gun.

Clearly, any person being hit by one of these craft would almost certainly sustain fatal injury and a significant amount of property damage could be inflicted from the ballistic effect alone if one of these craft were to hit a vehicle, building or other structure. This represents an extremely severe consequence.

Explosive effects:
Most of these RC jets carry around 6-8 litres of Jet-A1 fuel which has an energy density of 43MJ per Kg (over 277 mega Joules per tank-full). When involved in a high-speed impact (such as an RC jet crashing into a solid structure or the ground at speed), the rapid dispersal of this fuel and its rapid combustion has the potential to release as much explosive force as 60Kg of TNT (the latter having an energy density of just 4.8 MJ per Kg). The destructive and potentially lethal effect of such an explosion represents an extremely severe consequence.

Incendiary effects:
Even a non-explosive ignition of the jet-fuel carried by one of these RC craft poses a huge fire-risk, since the dispersal of that fuel is likely to be over a wide area due to the momentum associated with such a high-speed impact. In the event that persons or property are in the vicinity of such an impact, a very real risk of severe injury due to burns or significant property damage due to fire is possible. This represents and extremely severe consequence, especially at a time when a total fire ban is in place. Please review the videos linked to on the webpage: [http://tokoroaairfield.com/airport1.html](http://tokoroaairfield.com/airport1.html) for video evidence of this.
Toxicity effects:
In the event of a crash that does not involve fire, the leaking jet fuel will contaminate ground soil and any crops. It should be noted that the field where most crashes of RC jets occur is presently sown in maize and thus there could be losses to the farmer.

Identified Risk factors:
- operator experience/skill
- equipment used
- poor procedures
- operating environment

Operator experience/skill
Observation over the past 10 years has shown that although some of those flying RC model jets at NZTO exhibit reasonable skills, a good number also clearly lack the necessary disciplines, skills, experience and knowledge to safely fly such a high-risk model in this environment. This is evidenced by the high number of crashes and other “incidents” involving RC jets that have occurred at the airfield.

Equipment used
Whist some of the equipment used is of satisfactory quality, there is still evidence that unsuitable equipment and components are being inappropriately used. Examples of this are fruit-juice containers being repurposed as fuel tanks, the said containers lacking the strength to contain the volatile Jet-A1 fuel in the event of a crash. Likewise, it has been observed that not all the RC equipment used is suitable for the highly demanding task of flying an RC Jet, nor is it installed correctly.

Likewise, the radio control equipment used to operate these models is on a “public use” part of the radio spectrum (the 2.4GHz ISM band) which offers no protection from interference. (more on this below).

Operating Environment
This is the single largest risk factor, since at NZTO, these fast, powerful potentially lethal models are flown in very close proximity to people and property such as hangars which contain aircraft and aviation fuel.

Another factor is that the RC systems used in these craft operate on the 2.4GHz ISM band, a band that was never designed for this application and which must be shared with a wide variety of other applications such as wifi systems, wireless video equipment, RC toys, etc – and even microwave ovens which operate at power levels hundreds of times that available to RC model fliers. The close proximity of flying to the houses in Lochmaben and Dumphries Road, as well as the Amisfield Primary School is cause for significant concern since not only are these houses and school a source of potential interference that could affect the radio-control systems used but they are also vulnerable to any RC jet model which flies out of control.

The flight time from the runway to houses in Lochmaben road (a distance of barely 400m) is as little as four seconds and the Amisfield primary school (with several hundred pupils in class during weekdays) is less than 700m (as little as 7 seconds of uncontrolled flight).
It should be noted that it is very rare (often simply not allowed at all) for RC Jets to be flown anywhere near schools or domestic dwellings in other countries and it is very common for protective 3m-high chain-mesh fencing to be mandated between spectators and the flight line at European jet-flying venues.

Videos showing the European fencing requirements and the dangers to spectators that any RC model aircraft can represent are shown on the webpage at: http://tokoroaairport.com/airport1.html

Mitigation measures

Unfortunately, due to the very dangerous nature of the models flown at an RC jet meeting and the unsuitable/vulnerable environment that the Tokoroa Airfield and surrounds represents, there are few ways to effectively mitigate the risk that these fast, heavy, dangerous models represent.

Possible mitigation strategies would include:

1. the requirement for effective fire-fighting equipment to be on-field at all times the RC jets are flown. This would involve significantly more effective equipment than a few hand-held fire extinguishers since, during the warmer months, a fire can rapidly become established and spread, requiring the presence of an engine and trained fire-fighters.
2. The erection of chain-mesh fencing to protect spectators and other persons at the airfield from risk of being hit by errant RC model jets (as per the European standard).
3. Restricting the operation of RC jets to times when children are not in class at the Amisfield school.
4. A more effective pilot testing/certification regime than is currently in place (the USA requires all RC jet fliers to obtain a “turbine waiver” before they can legally fly their craft.
5. Independent scrutineering and testing of the models to be flown since observations at previous events and the resulting incidents clearly indicate that this task can not be adequately performed by those involved. Witness the number of crashes and incidents related to preventable equipment failure as evidence of this.
6. A limit as to the maximum weight, speed and fuel capacity of RC jets flown at NZTO so as to reduce the kinetic, explosive and incendiary energy of the craft involved. The USA restricts RC jet craft to a maximum speed not to exceed 200mph (320KPH) yet the NZJMA regularly fly models capable of significantly more than this speed. Energy is a function of the square of velocity so doubling the speed of a model increases its energy (destructive force) by a factor of four. Even small increases in speed produce significant increases in destructive potential.
7. Independent monitoring and enforcement of rules and regulations as laid down for the use of NZTO and RC models by the SWDC, MFNZ and CAA. To date, the monitoring and enforcement of these rules has been extremely lax and this contributes significantly to the level of risk associated with this activity. It also means that in the event of an incident, any insurance claims by the fliers would likely be declined by their insurer, exposing the SWDC to significant liability.
8. An advisory to all Amisfield residents to disable their wifi equipment at times when
the RC jets are flying so as to reduce the risk of interference with the radio-control equipment used in these models.

9. Restrict public access to the airfield and adjacent clubs during all times that the RC jet models are flying so as to reduce the risk of injury, or worse, in the event of an incident.

Probabilities
The probability of a crash involving an jet powered RC model aircraft at the Tokoroa Airfield is medium to high.

Over the past 10 years there have been a good number of significant (total loss) crashes involving these models and it has been largely “dumb luck” that the consequences of these crashes has been minimal so far. On too many documented occasions, these crashes occurred within tens of metres of spectators or bystanders. Only the slightest change in wind or timing could have resulted in severe injury or death as a consequence.

RC jet flying at the Tokoroa airfield presently does not provide enough protection for persons or properties in the vicinity of the airfield and, without significant changes, it is only a matter of time before a significant incident has a very negative consequence.

Luck is not a satisfactory method of managing or mitigating risk.

Conclusions
Ultimately, there is no simple way to effectively mitigate or even usefully reduce the very significant risks associated with the flying of large, heavy, fast, potentially explosive RC model jets at the Tokoroa Airfield. It is therefore the recommendation of the author that the flying of jet-powered RC model aircraft be halted in the interests of public safety and the safety of hangar owners, neighbouring clubs and nearby houses, as well as the Amisfield Primary School and its pupils.

Failure to acknowledge and immediately address these significant risks and their potentially severe consequences would effectively expose the SWDC to liability, in the event that any of the aforementioned risks resulted in damage to property or injury/death to persons.

History of incidents involving RC jets at NZTO from 2007 to 2014
- 3 mid-air break-up crashes into the motocross track (narrowly missing spectators at the motorcross club on two occasions)
- 1 pilot error crash into the motocross track with large incendiary effects
- 1 pilot error crash into runway at high speed, narrowly missing other pilots by just a few metres.
- 1 equipment failure crash (and resulting fire) into area used by spectators and parked aircraft. An aircraft had been parked in that position just 20 minutes prior.
- 1 failure caused by lack of knowledge/experience resulting in a crash into the gokart club grounds
- many crashes into the field immediately to the NE of the runway with varying outcomes and caused by pilot error, inadequate preflight procedures and equipment failure.
The Author:
Bruce Simpson is a world-recognised expert in the hobby of RC model aircraft, publishing two YouTube channels which have a combined audience of over 175,000 subscribers and a total view-count in excess of 65 million.

Simpson is also a widely published writer, reviewer and columnist on topics related to the hobby, featuring regularly in such long-running publications as Airborne Magazine.

As a result of his expertise and experience, Simpson is also a sought-after consultant to several very large RC model product manufacturers and his reviews are widely recognised as the most objective and informative to be found anywhere.

One of his books, on jet engine design and construction for RC models has sold in excess of 40,000 copies world-wide.

Simpson also enjoys a strong background in professional electronics, RF, digital communications and software, stretching back over 40 years. His articles on 2.4GHz radio control technology have been republished many times by various magazines, websites, clubs, groups and model-flying organisations around the world.

Simpson's own RC model flying experience spans a blemish-free record of over 45 years of designing, building and flying a wide variety of RC model aircraft.