

Agenda item 4 a,
“Water rocket event”

Report on APRSAF International Water Rocket Education Workshop
30 June – 3 July 2008, Melbourne, Australia

I. Introduction

A. Background and objectives

1. During the eleventh session of the Asia-Pacific Regional Space Agency Forum (APRSAF), held in Canberra, Australia, in November 2004, the Space Education and Awareness Working Group (SEA WG) reached an important agreement to stimulate interest of children in space activities while learning basics of scientific principles. It was the agreement to hold a regional Water Boosted Rocket Competition. The members of SEA WG were then encouraged to organize water boosted rocket competitions in their countries to select participants for the regional competition.

2. Following the first one in Kitakyushu, Japan, in October 2005, APRSAF Water Rocket Events were organized in Jakarta, Indonesia, in December 2006, and in Bangalore, India, in November 2007, immediately following the annual sessions of APRSAF. Between 40 and 50 students and their teachers or leaders from about 10 countries¹ participated in each event. The number of countries that held national competitions steadily increased over the past three years. Some countries included science and math quizzes in the selection process. Some other countries evaluated the performance of water rocket launch by not only the flight distance but also the accuracy of launch or duration of flight time. Various countries explored creative ways and means to make water rockets and launchers.

¹ The numbers of countries, student competitors and accompanying teachers and leaders that participated in 2005, 2006 and 2007 are as follows: 2005 – 10 countries, 18 students, 20 teachers/leaders; 2006 – 13 countries, 29 students, 21 teachers/leaders; 2007 – 10 countries, 24 students, 17 teachers/leaders.

3. In order to provide opportunities for the teachers and leaders accompanying the participating students to exchange their experiences and ideas for making water rockets and launchers, the organizers of the Second APRSAF Water Rocket Event convened a leader session. Lively discussions and demonstrations of their water rockets and launchers took place. As a result, 25 participants of the session agreed to set up a network of educators and instructors of water rockets, in order to continue their exchange of information and experiences with water rocket activities for educational purposes.

4. In time for the Second APRSAF Water Rocket Event, the Space Education Center of Japan Aerospace Exploration Agency (JAXA) had developed an Educator's Manual for Water Rockets and its DVD for distribution to the members of SEA WG as well as the teachers and leaders accompanying the students who participated in the Water Rocket Event. The Manual and DVD aimed to stimulate discussions among interested teachers and educators to develop teaching methods and materials that would better meet their educational needs and objectives.

5. While water rocket launch events can get young people excited and interested, there is a need to offer more than just excitement and fun in order to contribute to enhancing education for young people. With the proper guidance by skilled and knowledgeable instructors or educators, activities using water rockets could stimulate young people's intellectual, scientific curiosity and cultivate their challenging spirit to pursue excellence. There is a need to increase the number of such instructors and educators and to provide them with adequate support environment to further promote water rocket activities to enhance education for young people.

6. In order to discuss and collectively identify ways and means to expand the pool of skilled and informed educators who can effectively use water rockets to enhance education for young people and to establish a sustainable network of support for those educators, the APRSAF International Water Rocket Education Workshop was convened from 30 June to 3 July 2008 in Melbourne, Australia, by the Victorian Space Science Education Centre (VSSEC) and JAXA.

7. The Workshop aimed to achieve the following objectives:
 - i) To exchange “lessons learned” in promoting water rocket activities for educational purposes and to identify challenges;
 - ii) To discuss and identify the common educational objectives of water rocket activities;
 - iii) To identify useful teaching materials for water rocket activities and ways and means to share those materials among interested teachers and educators;
 - iv) To identify steps to take to establish a functional network of interested teachers and educator as well as experts from space-related fields to support each other in further promoting water rocket activities for educational purposes.

B. Programme

8. At the opening of the Workshop, welcoming and introductory statements were made by the Japanese Co-Chair of APRSAF Space Education and Awareness Working Group and the representatives of VSSEC, Department of Education and Early Childhood Development of Australia, Australian Telescope National Facility and JAXA. A keynote presentation was also made to provide the overview of the universe, our solar system and the uniqueness of our planet Earth as well as to indicate the overall direction to be pursued through space education efforts.

9. The Workshop consisted of the following 6 sessions:
 - Session 1: Overall framework and approaches to promote water rocket activities
 - Session 2: Education materials and methods to promote water rocket activities
 - Session 3: Hands-on session on making and launching water rockets
 - Session 4: Strengthening support for teachers and educators to use water rockets for education
 - Session 5: Teacher’s training session: VSSEC programme on “Mission to Mars”
 - Session 6: Teacher’s training session: VSSEC programme on “Mission to the Orbiting Space Laboratory”

10. The first day of the Workshop was devoted to reviewing the water rocket activities in the context of space education and exchanging experiences in promoting water rocket activities in various countries through the presentations in Session 1 and reviewing the existing education materials relevant to water rockets, in Session 2. In the former session, 17 presentations were made by participants from 12 countries.

11. On the second day, all the participants had opportunities to make and launch their own rockets under the guidance of an experienced instructor and expert on water rockets. There was also the demonstration of various types of water rockets.

12. Session 4, on the third day, served as a wrap-up session on the discussions on water rocket activities for educational purposes. The participants also addressed the organization of future APRSAF Water Rocket Events.

13. The teacher's training sessions, i.e. Sessions 5 and 6, were organized by VSSEC on the third and fourth days. With generous support by VSSEC, all the participants were provided with opportunities to experience VSSEC training programmes for schools and to use facilities and course materials at VSSEC.

C. Attendance

14. A total of 32 teachers and educators as well as space scientists and engineers from the following countries participated in the Workshop: Australia, Argentina, Bangladesh, Colombia, Indonesia, Japan, Malaysia, Philippines, Singapore, Sri Lanka, Thailand and Vietnam.

15. Funds and in-kind support were provided by JAXA, VSSEC, Department of Education and Early Childhood Development of Australia, Engineers Australia, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Australian Science Teachers Association. The co-sponsors defrayed the cost of air travel and accommodation for 14 participants.

II. Promoting water rocket activities

16. The participants heard the lecture on real rockets versus water rockets and reviewed in detail how the same scientific principles were applied to both, such as general principles of rocket flight and fundamental parameters of rocket propulsion as well as stability and control. They had the opportunity to hear the first-hand experience of the operation of the launch vehicles and of the research and development of future rockets, including near future rocket control and responsive operation..

A. Water Rocket activities in Asia and the Pacific

17. The participants reviewed the efforts made at the regional level in Asia and the Pacific, through the series of APRSAF Water Rocket Events, held annually from 2005. They also noted that the next Event would be held in Ha Noi, Vietnam in December 2008. They further noted that efforts were being made to identify methods to exchange ideas and skills developed for water rockets, to establish a network of teachers and leaders of water rocket activities, to develop learning materials for school children in their own languages and to further promote water rocket activities in various countries in their local languages.

18. The participants heard the presentations on the activities at secondary schools in Queensland and South Australia. At a high school in Queensland, where 30,000 students were pursuing engineering, water rocket activities had been introduced to provide the students with opportunities to design, build and evaluate performance. While the time allocated to the water rocket activities was currently limited, to about one to two week, it was being planned to allocate more time, to give more learning opportunities for the students.

19. A teacher from South Australia presented the positive experiences with the Australian International Space School (AISS), which had been organized since 1997. It was suggested that water rocket activities could be integrated into the programme of this initiative. The water rockets could be used to teach mathematic contents, such as trigonometry. AISS also provides opportunities to interact with students from other countries, such as Germany.

20. A teacher from New South Wales presented the experiences with the Young Astronaut Clubs, which also carry out activities to provide opportunities to meet students from various countries. An Australian student, for example, was invited through this international network of Young Astronaut Clubs to participate in Children's Space Summit, held in Tomakomai, Hokkaido, in conjunction with G-8 Summit.

21. In Bangladesh, the Educator's Manual for Water Rockets, developed by JAXA in 2006, had been used to promote water rocket activities. The launchers were developed according to the Manual. Water rockets were also used for New Year's celebration. The water rocket launch was a popular part of the series of events organized in Enayatpur for the celebration of the World Space Week, drawing a large number of interested students.

22. The National Institute of Aeronautics and Space of Indonesia (LAPAN) had been carrying out water rocket activities over five years by now. Some advanced water rocket activities were being introduced as inter-disciplinary projects for college students. In cooperation with the remote control hobby community, college students were developing a remotely controlled launcher.

23. The water rocket was introduced at the State University of Indonesia for candidates for physics teachers to teach physics. Using water rockets changed the image of physics among the students, and some statistics indicated a dramatic increase in the percentage of the students who now consider physics as an interesting and fun subject to learn. The participants were presented with a table showing the correlation between science subjects in the national curriculum in Indonesia and scientific elements that can be taught with the water rocket.

24. Through its National Space Agency (ANGKASA), Malaysia had been organizing a nation-wide water rocket competition, with the participation of 16 States. The competition was open to all secondary school students, who compete in the following three categories: "Best Design", "Best Target" and "Best Parachute". Through their participation in the competitions, the students learned physics theories and concepts as applied to the water rockets.

25. The water rocket was being used as part of the training programmes for school teachers in the Philippines, including those from elementary schools. The water rocket was found effective in teaching elementary school children the scientific principles applied to rocket flight, the effect of air pressure and the weight of air, for example. What they learned through the water rocket would facilitate their scientific learning in the secondary education.

26. Through the educational activities undertaken by SpeedE Ltd., a private entity, 100 schools out of 150 schools in Singapore were involved in the water rocket activities. The participating school students had found it easier to learn Newton's Laws as well as safety issues. In the national competition in Singapore, the participating students compete in such categories as "parachute rocket", "car-fit race" and "precision targeting". SpeedE was also using water rocket activities to foster friendship overseas, taking students from Singapore three times a year outside the country, in March, June and December to meet students of other countries.

27. The water rocket activities started in Sri Lanka as the result of the agreement reached by APRSAF Space Education and Awareness Working Group during APRSAF-11. To be selected for participation in APRSAF Water Rocket Events, the participating students not only had to perform well in the water rocket launch but also had to demonstrate their knowledge of mathematics and physics as relevant to the water rocket. While it started with a small effort, in 2007, sponsors had come up to fund the participation of three additional students.

28. The water rocket activities in Thailand had been successfully organized by the National Science Museum over the past three to four years with the participation of a large number of students. The water rocket was found to present intellectual challenges for more advanced students than primary and secondary school students. It was suggested that the annual APRSAF Water Rocket Event could introduce a new, advanced category in order to further stimulate intellectual challenges for the students, for example, to introduce the parachute rocket category or the electronically controlled water rocket.

29. The Vietnam Academy of Science and Technology (VAST) was supporting water rocket activities, which had been found to make it easier for the school

students to learn about science and technology, stimulate intellectual curiosity of children and provide excellent opportunities for the students to get involved in practical experiments. VAST was also making efforts to seek for media coverage of the water rocket events.

30. While the water rocket was first introduced in Vietnam by the Soviet Union at that time in 1980's, a high school teacher from Ho Chi Minh noted that the materials to build and launch water rockets were not easy to use and were limited in number. There was also little room for creativity for the students. This changed as a result of the UNESCO Space Education Workshop held in Ho Chi Minh in March 2006, where JAXA introduced the water rockets as promoted in Japan. Following the Workshop, a group of about 30 students started to make many innovations with their water rockets, and more and more students had joined the group. The water rocket activities were effective not only for enhancing science education but also for cultivating team spirit among the participating students. It was suggested that water rocket activities for educational purposes could be further enhanced if a scientific game using the water rocket could be developed.

B. Water rocket activities in Latin America

31. The policy of the National Commission for Space Activities (CONAE) provides that within 7 years, 2 million children and youth should use space information in their daily activities. The water rocket activities had been introduced as part of the implementation of this policy, following the teachers training session organized with UNESCO in October 2007, including the practical session to make and launch water rockets.

32. The water rocket activities were first introduced in Colombia in December 2005 by the UNESCO Space Camps held in multiple cities. In Medellin and Bogota, JAXA Space Education Center introduced the water rocket launch activities using the materials from Japan. A practical session for the students to make water rockets was also organized at the Planetarium in Bogota. Following the Space Camp, through the Planetarium in Bogota and now MALOKA, a private educational organization with a network of more than 4,500 teachers in

Colombia, Venezuela and Panama, more than 5,000 children and 400 teachers in Colombia had learned about and experienced the water rockets.

C. Educational materials to promote water rocket activities

33. The participants noted that JAXA Space Education Center had developed and distributed in Japanese and English the Educator's Manual for Water Rockets and its accompanying DVD, showing steps by step how to build water rockets and launchers and how to conduct a water rocket launch while ensuring the safety. In cooperation with UNESCO, the Center was making the set of Manual and DVD in Spanish in response to positive feedback received from teachers and educators in Latin American countries. The Center was also discussing with space-related entities in Brazil to make the Portuguese set. In Africa, the Manual and DVD were also distributed among the teachers who participated in the hands-on water rocket session of the UNESCO Space Education Workshops held in May 2008 in Dar-es-Salaam and Arusha, Tanzania.

34. The participants agreed that the Educator's Manual and DVD mentioned above contributed to promoting water rocket activities for educational purposes. It was pointed out that the availability of the teacher's guides in local languages would further facilitate the introduction of water rockets at schools.

II. Hands-on session on making and launching water rockets

35. One full day was devoted to the hands-on session on making and launching water rockets. At the beginning, various types of water rockets were presented with the explanations on the structures of those rockets, the engineering innovations and concepts involved and their background.

36. Under the guidance of an experienced instructor from Japan, all the participants of the session built one basic-type of the water rocket. They built smaller, indoor-type rockets, rockets with parachutes as well as rockets using balloons in groups on a selective basis and experienced the launch of all types of rockets that they built.

37. The participants noted that one of the most important aspects of the water rocket activities for educational purposes was to let young people build rockets using only those materials that were readily available without relying on ready-made materials and encourage them to design their own unique rockets, so as to encourage young people to exercise their creativity and to cultivate their engineering spirit. The participants also noted the “Idea Water Rocket Contest” had been held in Japan annually over the past decade.

III. Observations and recommendations

A. Lessons learned in promoting water rocket activities for educational purposes

38. The participants agreed that the existence of a coordinating entity was essential to promote water rocket activities among a large number of young people. Support by a ministry or any other government entity responsible for education significantly facilitates the organization of nation-wide water rocket activities, such as national competitions. Private entities could support water rocket activities. There is a need to consider better approach to government entities, industry as well as the media to seek for support.

39. The participants agreed that supporting teachers was essential. Showing the teachers the links between the water rockets and the existing curriculum is important, and teachers should be provided with technical and financial support to use water rockets to teach science, so that water rocket activities could be used within the existing curriculum.

40. It was pointed out that the teachers and students should also be made aware of applications of rockets to support other areas of space activities, such as satellite applications and operations.

41. The participants agreed that water rockets were useful as introductory education materials to teach many disciplinary scientific areas, bearing in mind the importance of teaching correct physics. The water rocket activities can also address social science aspects and human aspects as well.

42. The participants agreed that organizing international water rocket events was essential to connect and encourage the young people and teachers involved in water rocket activities. Publicity of the benefits of water rocket activities, emphasizing their scientific contents as well as international cooperation aspects, stressing peaceful purposes, would be useful to expand water rocket activities.

B. Organization of future APRSAF Water Rocket Events

43. Building upon the experiences of some countries, the participants recommended that additional, new categories for water rocket launch competition should be considered for future APRSAF water rocket launch competitions, to compete for long flight time, high altitude and flight distance. The participants could also compete for the creativity in designing the rockets. The category where the participants compete for accuracy of launch could be the compulsory category to participate.

44. Depending on the category, a set of elements to be fixed should be determined ahead of the time. The participants agreed that at the least, the plastic bottles used for making rockets and the level of air pressure should be fixed and universally applied to all water rockets for safety reasons.

45. The participants recommended that as part of the programme for APRSAF Water Rocket Event, the participating students could be invited to present their water rockets that they have built, emphasizing the points where they have applied their unique ideas and made extra efforts. Their presentations could also be judged and taken into account in determining the winners of the Event.

46. It was pointed out that for future APRSAF Water Rocket Events, winners could be determined not on an individual basis but rather by overall team performance of teams, so as to encourage team work. International teams consisting of students from different countries could also be invited to participate.

C. Creating a network of educators and teachers to promote water rocket activities for educational purposes

47. The participants agreed that it was important that at the least, the participants of this Workshop should be in contact with each other. For that purpose, the participants agreed to set up an Internet based “Wiki” site, where anybody registered with the site could upload and download any information and electronic files.

48. The participants welcomed the generous offer by VSSEC to set up a proto-type Wiki site to exchange information, messages and education materials relating to water rockets. It was pointed out that a section on water rocket parts and suppliers should be included in the Wiki site.

49. The proto-type was created during the Workshop registering all the participants of the Workshop as the users. This proto-type was followed with a more structured, robust Wiki site with the following URL address:

<http://wiki.vssec.vic.edu.au/waterrockets/moin.cgi/FrontPage>

50. The participants agreed that the above Wiki site should be introduced at the upcoming meeting of APRSAF Space Education and Awareness Working Group and that all members of the Working Group should be provided with access to the Wiki site. The participants also agreed that through the members of the Working Group, the Wiki site should be introduced to teachers and educators in their countries who could benefit from the Wiki site and become users.