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RERF

# update

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Radiation Effects Research Foundation  
Hiroshima and Nagasaki, Japan

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**RERF Teaches School Children about Radiation**

## Workshop

**ICRP-RERF Joint Meetings Held in Hiroshima and Tokyo  
“Very Good for Science”**

## Science Articles

**Irradiation at different fetal stages results in different  
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## Sixth Board of Councilors Meeting Held at Hiroshima RERF

The sixth meeting of the Radiation Effects Research Foundation (RERF) Board of Councilors (BOC) took place on June 16–17, 2016, at the Hiroshima Laboratory. The meeting was attended by seven of the eight councilors, as well as directors and auditors. Representatives of the U.S. and Japanese governments and the U.S. National Academy of Sciences also attended as observers. Executive Councilor Dr. Shelley A. Hearne served as the moderator.

In their remarks at the beginning of the meeting, the representatives of the U.S. and Japanese governments stated that RERF's research achievements were global assets and that RERF should continue to serve as a center of excellence (COE) on radiation health effects studies. They also expressed their appreciation to atomic bomb survivors and their children for their dedicated cooperation in the studies.

The meeting's major agenda items and discussions were as follows. Reports on FY2015 activities, settlement of accounts, and audit results were presented and approved. Plans for FY2016 activities were reported, including research projects, training programs, public information programs, and the activities necessary to carry out these projects, as well as budget estimates for all the activities. An explanation of the strategic plan, which

looks into the future of RERF, was presented, and the newly introduced internal audit system was described, followed by active discussions.

Scientific Advisory Committee Co-chair Dr. Shunichi Yamashita reported the 43rd Scientific Advisory Committee's recommendations, made during the March 2–4, 2016, meeting at the Hiroshima Laboratory, when a focused review was made of the Department of Clinical Studies. General recommendations included (1) consideration of a biennial review cycle to reduce meeting preparation work, (2) development of a strategic plan and research clusters to cope with the aging of research scientists and facilities, and (3) increased involvement of the Department of Statistics at the early stage of research proposals. RERF's responses to these recommendations were also discussed at the meeting.

Next, two councilors, two auditors, and two scientific advisors were appointed. Appreciation was expressed to two outgoing councilors for their service.

Finally, it was decided that next year's BOC meeting would be held at RERF's Nagasaki Laboratory, June 15–16, 2017. On June 14, an informal meeting of councilors will take place prior to the BOC meeting, as was the case in 2016.



Participants of Board of Councilors meeting



## Open House 2016 Held at Hiroshima and Nagasaki RERF



Child learning to use labware (pipette) [right], with RERF staff, Hiroshima

Hiroshima and Nagasaki Open House events in 2016 were crowded with visitors for the two days, despite the stifling hot summer weather. We hope that these two days proved meaningful for visitors to further understand RERF. The following account describes the Hiroshima and Nagasaki Open House events.

### Hiroshima Open House draws more than 1,000 visitors

RERF's 22nd Open House in Hiroshima was held at the Hiroshima Laboratory over the two days of August 5 and 6, based on the slogan "Come to RERF!"

Including panel displays of the newest RERF research, which has continued thanks to the understanding and cooperation of atomic bomb survivors and numerous others, two special exhibits were introduced: "Epidemiological Study of Health Effects in Fukushima Emergency Workers," a project that was entrusted to RERF by Japan's Ministry of Health, Labour and Welfare (MHLW) in 2014, and "Considering the health effects of low-dose radiation exposure based on atomic bomb radiation studies."

At the "Science Corner," there were several 'hands-on' experiments such as a liquid-nitrogen show, a DNA-extraction presentation, and a chance for electron microscope observation with cooperation from Japan Electron Optics Laboratory Co., Ltd. (JEOL), as well as a quiz/stamp rally during which visitors, notably lots of children, engaged in the contest while strolling around the facilities. At the Department of Clinical Studies, our staff bought a small human skeleton model, which was given the name "Hone-hone

Kun" ("hone" means bone in Japanese).

The main event of this year's Open House were guided tours of the Biosample Center's robotic biorepository, which started operations in 2015. The tours were provided every hour. On the tours, visitors listened to an explanation about the stored samples and then toured the robotic freezer system and liquid nitrogen tanks. Another exciting first-time event was the showing of an animated film in Japanese for the study of peace. The film was borrowed from the Hiroshima Peace Memorial Museum.

Four lectures were planned for the Open House event. On August 5, Dr. Hiromi Sugiyama, Acting Office Chief, Tumor & Tissue Registry Office, Associate Senior Scientist, Department of Epidemiology, gave a lecture titled "What are Cancer Registries?" given that cancer registration was enshrined into law starting this year in Japan. Another popular lecture since it was first held at the 2014 Open House was "That's why translation is fun!" delivered in English by Mr. Jeffrey L. Hart, Chief, Public Relations and Publications Office.

The next day, August 6, Dr. Norio Takahashi, RERF Consultant, gave a lecture about the basics of radiation titled "What is radiation?" and Dr. Kyoji Furukawa, Associate Senior Scientist, Department of Statistics, delivered the lecture "Statistics can be fun!" illustrating the likelihood of the local Hiroshima Carp baseball team winning the pennant this season.

For both days, a total of 1,003 guests visited the Hiroshima Laboratory. A compact route was established to make it easier for visitors to take in everything without becoming tired. As a result, there were many families with children, people



Small human skeleton model "Hone-hone Kun" used in Clinical Studies exhibit, Hiroshima

from overseas, and Japanese school students. This year's Open House as well featured lots of communication between visitors and RERF staff.

### Many visitors participate in Nagasaki Open House

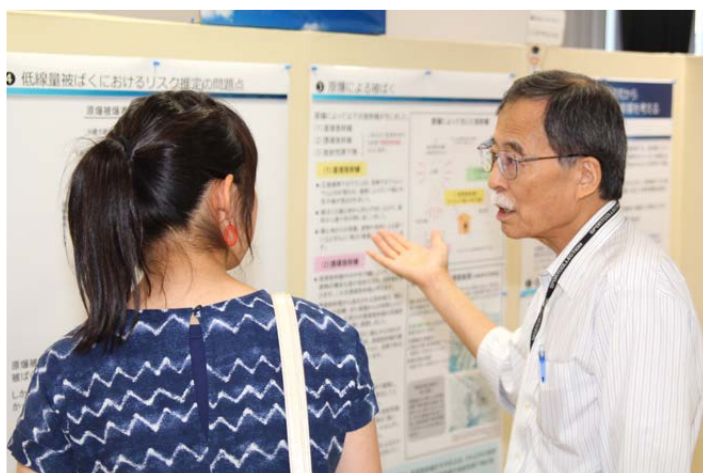
RERF's 20th Open House in Nagasaki was held at the Nagasaki Laboratory over the two days of August 8 and 9, 2016, based on the slogan "Come to RERF!"

Beautiful weather was evident on both days, with the many visitors and RERF staff able to share an enjoyable time together. The two special exhibits were "Epidemiological Study of Health Effects in Fukushima Emergency Workers (NEWS)" and "Considering the health effects of low-dose

radiation exposure based on atomic bomb radiation studies." These special exhibits drew considerable interest from visitors. On August 9, Dr. Kyoji Furukawa, Associate Senior Scientist, Department of Statistics, gave a lecture titled "Statistics can be fun!," which marked his third time to speak at the Nagasaki Open House. The lecture was so popular among visitors that some in the audience had to stand to listen, since no empty seats remained.

At the demonstration corner, experiments with liquid nitrogen, electron microscope observation of red and white blood cells, posing in commemorative photographs in a white lab coat, and listening to the heart and lungs with a stethoscope were all a hit with children, whose laughter could be heard all around. For adults, arteriosclerosis testing, bone density measurement with ultrasound bone densitometry, body fat measurement, and urinalysis were popular. It was impressive to see visitors regardless of age enjoying themselves with RERF staff.

A total of 503 people visited the Nagasaki Open House over the two days this year, and more than 65% of that number visited for the first time. The Open House has become a good opportunity for many people to learn about RERF.



Dr. Ohtsura Niwa, Chairman, explaining about scientific research to visitor, Nagasaki



Scene inside lecture "That's why translation is fun!," Hiroshima

## RERF Teaches School Children about Radiation

**Reiko Horimukai, Assistant Chief  
Public Relations and Publications Office**

The second round of RERF's project to present lectures about radiation in area schools took place on October 11, 2016, with a visit to the Hiroshima Suzugamine Elementary School. The theme was "A school-visit lecture concerning radiation: its beneficial and harmful uses." The project's aim is to teach children about radiation, and the lecture was attended by 34 fifth graders and several parents, as part of elementary school parent-teacher-children (PTC) activities. Dr. Norio Takahashi, RERF Consultant, presented the lecture, which Mr. Yuji Yoneyama, a certified radiation protection supervisor and Assistant Section Chief, Department of General Affairs, supported as teaching assistant.

The lecture began with demonstrations of the various characteristics and types of radiation using slides, balls of various sizes, and a flashlight. Dr. Takahashi then introduced examples of beneficial uses of radiation, including health examinations, cancer treatments, and airport screenings. He also explained harmful effects of radiation, including cellular damage that can lead to cancer development. He concluded by explaining that an understanding of radiation's both beneficial and harmful aspects is important for its effective use.

After studying radiation basics, the children and parents tried their hand at scientific experiments. While it is known that radiation dose decreases with distance from the source of radiation, the observers verified this phenomenon by conducting measurements with a survey meter. Children saw the decrease in radiation with increasing distance and thus directly experienced this particular characteristic of radiation.

The next experiment demonstrated the association between radiation and shielding. Wooden plates, even when several were placed together between a source of very low-level radiation and the survey meter, did not change the measurements. Next, participants used lead plates of various thicknesses. The thicker the lead plate, the lower the measurement value was; however, the val-

ues never reached zero. Dr. Takahashi explained to the participants that wood does not block radiation, while a sufficient thickness of lead does. He noted, however, that there is no place on earth completely free of radiation due to the naturally occurring radiation present everywhere.

Finally, the participants observed radiation using a 'cloud chamber,' the inside of which was lined with black paper. Alcohol was poured into the bottom of the chamber, and a very low-dose radiation source was placed inside, at the center. The chamber was covered with cellophane wrap and placed on dry ice. Because the bottom of the cloud chamber cooled, the alcohol became super-saturated. In minutes, a white line appeared and evanesced inside the chamber, like the contrails of an airplane. Then multiple white lines appeared and evanesced, reminiscent of the appearance of outer space. When announced that "These white lines are traces of radiation," a cheer arose from the children. Sometimes, multiple white lines appeared in a radial pattern, and we could see the faces of children light up as they came into contact with the magical world of science.

Our goal is for this lecture project to help children deepen their understanding of radiation. After the presentation, we left the school with the hope that the children felt more at ease with science in general.



Students listening to lecture about radiation



## RERF Public Lecture Held at Japanese Radiation Research Society Meeting



Opening scene of Public Lecture

The RERF Public Lecture in 2016 was presented as part of the 59th Meeting of the Japanese Radiation Research Society, with the Society acting as co-sponsor. The lecture was held in the evening of October 26 at the JMS Aster Plaza in Naka-ku, Hiroshima. About 120 persons attended, including Society participants and members of the public.

Because 2016 marked the fifth anniversary of TEPCO’s Fukushima Daiichi nuclear power plant accident, the Public Lecture featured four presentations based on the theme “Message to Fukushima

from Hiroshima and Nagasaki five years after the accident—harmony between health monitoring and scientific research.” Dr. Toshiya Inaba, Professor, Research Institute for Radiation Biology and Medicine of Hiroshima University, and Ms. Reiko Horimukai, Assistant Chief, Public Relations and Publications Office, RERF, served as co-presenters.

In his opening lecture, Mr. Sunao Tsuboi, Chairman, Hiroshima Prefecture Confederation of A- and H-Bomb Sufferers Organizations, spoke passionately about his own experiences immediately after the atomic bombing of Hiroshima. He



Dr. Inaba (upper left), acted as presenter at lecture, and three speakers: Dr. Kodama, Chief Scientist (upper right), Dr. Kai (lower left), Dr. Midorikawa (lower right)



Mr. Sunao Tsuboi speaking about his A-bombing experience

described how he roamed around the ruined city after being exposed to the bombing 1.5 kilometers from the hypocenter, how he prepared for death in the vicinity of Miyuki-bashi Bridge, and how he shouted out a warning to a young girl not to go in the direction of the blaze.

Every attendee in the hall was surely moved by Mr. Tsuboi's strong desire to communicate to as many people as possible about the true nature of the atomic bombings and the need to eliminate nuclear weapons for global peace.

Dr. Kazunori Kodama, RERF Chief Scientist, explained that RERF has been thinking about how to go about conveying its research findings to people in Hiroshima, Nagasaki, and throughout the world. He emphasized that RERF is making every effort to carry out such activities, including releasing information on its website, holding Local Liaison Council meetings, and hosting events such as the Open House and Public Lecture.

Dr. Michiaki Kai, Professor, Oita University of Nursing and Health Sciences, used figures and charts to present a readily understandable explanation of radiation protection systems and talked about how radiation protection standards are based on the outcomes of health effects studies conducted by RERF in Hiroshima and Nagasaki.



Public Lecture leaflet

Dr. Sanae Midorikawa, Professor, Fukushima Medical University, spoke about a major thyroid screening project conducted after the Fukushima accident for mothers who feared the onset of thyroid cancer among their children, noting that the outcome ironically multiplied the mothers' fears.

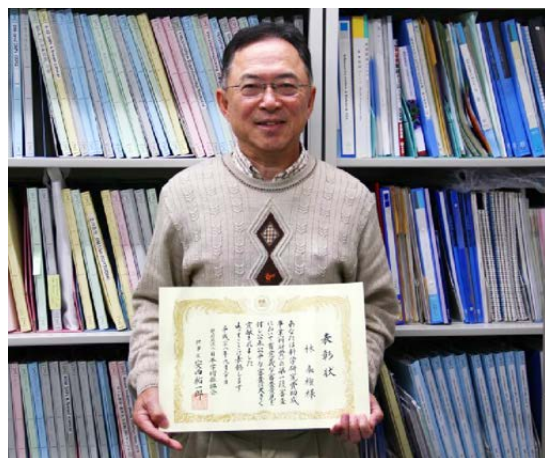
The last lecture reminded the audience of the importance of communication that is sensitive to the difficulties inherent in striking a balance between scientific research and health protection, thus avoiding misunderstandings between examiners and examinees.

## Dr. Hayashi Commended as Reviewer for Grant-in-Aid for Scientific Research Program

On October 11, 2016, Dr. Tomonori Hayashi, Assistant Chief, Department of Molecular Biosciences (and Fixed-term Research Scientist, Biosample Center) at the RERF Hiroshima Laboratory, was awarded a certificate of commendation by the Japan Society for the Promotion of Science (JSPS)\* for his work as a reviewer to determine the allocation of grants for the Society's Grants-in-Aid for Scientific Research program. The commendation was awarded on the basis of JSPS's great appreciation for Dr. Hayashi's work, which contributed to fair and impartial review.

Grants-in-Aid for Scientific Research are competitive research funds intended to significantly develop all areas of academic research (based on free ideas of researchers), from basic to applied science in all fields, covering projects in humanities and social sciences to natural sciences. Grants are awarded to creative and pioneering research projects after a peer-review screening process. JSPS reviews applications in a two-stage process, which consists of a first-stage review (of written propos-

als) and a second-stage review (panel review), both of which evaluate applications from a specialized viewpoint to ensure proper and fair grant-allocation



Dr. Tomonori Hayashi, Assistant Chief, Molecular Biosciences Dept., with certificate



screening. Furthermore, the Research Center for Science Systems (RCSS) reviews the process after screening, and those results are reflected appropriately in the selection of reviewers to serve on the review committee in the following fiscal year.

Based on assessments by the RCSS, first-stage reviewers who provided meaningful comments for the second-stage review are awarded commendation. In fiscal 2016, 268 reviewers, including Dr. Hayashi, were selected for commendation from among the 5,700 first-stage reviewers.

On his work for the Grants-in-Aid for Scientific Research program, Dr. Hayashi commented, "I have reviewed about 90 applications as one of the committee members. In order to evaluate submitted applications, an evaluation form with comments, along with scores, needs to be prepared for each application. It is very time-consuming work."

He further explained, "In addition, I need to give each application a score and sort all applications into a five-point-scale system. I took the review

very seriously, hoping that as many researchers as possible would receive proper and fair reviews and be awarded grants to work on their projects from the Grants-in-Aid for Scientific Research program."

Dr. Hayashi expressed his hope for this project in the future. "As a recent award trend, it seems to me that applied research leading to useful applications is immediately given more weight." Dr. Hayashi added, "But I think that in the long run, it is also important to fund and support work that focuses on basic research as well."

By having an RERF researcher act as a reviewer in this program, RERF can also learn more about how to undergo proper and fair/impartial research evaluation, insight that could contribute to great improvement in the quality of RERF's future research.

\*JSPS homepage

<https://www.jsps.go.jp/english/index.html>

## Staff News

**Noriko Inoue** was appointed as Visiting Research Fellow, Department of Clinical Studies, on May 1, 2016. **Yoichiro Kusunoki**, Chief (Senior Scientist), Department of Molecular Biosciences (concurrently assigned as Chief, Laboratory of Cell Biology), and **Michiko Yamada**, Chief (Senior Scientist), Division of Radiology, Department of Clinical Studies, both retired on June 30 under the mandatory age limit, but continue to perform research as Fixed-term Research Scientists (Department Chief [Senior Scientist], Department of Molecular Biosciences [concurrently assigned as Chief, Laboratory of Cell Biology] and Chief

[Senior Scientist], Division of Radiology, Department of Clinical Studies, respectively) starting July 1. **Fukiko Mitsui**, Fixed-term Research Scientist, Division of Medicine, Department of Clinical Studies, retired on July 31. **Takanobu Teramoto**, Executive Director, resigned, and on October 1 **Akira Hashizume** was newly appointed to the post of Executive Director.

The following are a message of greetings from **Dr. Hashizume**, newly appointed Executive Director, and a farewell message from **Mr. Teramoto**, former Executive Director.

## Greetings and Farewells

### Greetings

I would like to begin by expressing how honored I feel to be appointed as Executive Director of the Radiation Effects Research Foundation (RERF). RERF is an institute at which epidemiologists and public health specialists dream of working, because it is the site of the largest and longest cohort research in the world.

My parents had just conceived me when the Lucky Dragon No. 5 was exposed to nuclear fallout. I spent my childhood being exposed to nuclear fallout caused by hundreds of nuclear tests

conducted aboveground. In the liberal arts program at my university, I wrote a report on the structure and principles of atomic weapons with the aim of earning credit for a course on energy. Looking back now, atomic bomb radiation and I appear to have had a deep connection with each other.

After graduating from medical school, I engaged in public health administration at Japan's Ministry of Health, Labour and Welfare (MHLW) for 25 years. When just beginning my career at MHLW, I received training at the U.S. Department of Health

**Akira Hashizume**  
Executive Director



New Executive Director, Dr. Akira Hashizume

and Human Services. During this training period, I had an opportunity to witness America's views of the atomic bombings by visiting the Los Alamos Historical Museum. When I was working on my assignment at the MHLW bureau responsible for Medical Law, I was in charge of work related to the protection of patients and medical workers from medical radiation risk. Part of my role was to undertake the necessary arrangements both inside and outside MHLW to apply the recommendations from the International Commission on Radiological Protection (ICRP) to domestic law. Upon enactment of the Atomic Bomb Survivors' Assistance

Law, I had the chance to meet with A-bomb survivors groups and RERF staff. It was then I found out that I shared a birthday with former RERF Chairman Dr. Itsuzo Shigematsu.

In the course of my duty authorizing diseases determined to be caused by the atomic bombings, I read numerous study reports published by RERF as well as the dosimetry system DS86 report. Immediately after the Atomic Bomb Survivors' Assistance Law was enacted, I was dispatched to the Hiroshima city government to help in implementing the law and spent three years working there. During my time in Hiroshima, I visited Vienna on behalf of the Hiroshima mayor to give a speech and to lobby for the 10th International Conference of the International Radiation Protection Association (IRPA10) to be held in Hiroshima in 2000. The Conference was convened here that year, becoming one of my good memories. I was also involved in implementation and management of a healthcare project for the residents of Semipalatinsk as part of the Japan International Cooperation Agency (JICA)'s work.

I cannot help but believe that I was destined to work at RERF due to my abiding connection with radiation. I am determined to fulfill my duties as RERF Executive Director in recognition that this will be the last phase of my life's work.

## Farewell Message

### Takanobu Teramoto Former Executive Director

About two months have passed since my retirement from the post of RERF Executive Director at the end of August 2016. I would like to extend my appreciation to all RERF staff for the support and cooperation they extended to me during my tenure.

I was blessed with a number of rare opportunities in my 11 years at RERF. For one who had not been particularly involved in science or medicine, it may have been fate of sorts that I was able to serve in that position for so long, given as how I often found myself feeling my way around, akin to one of the characters in the parable of the 'blind men and the elephant.'

I am deeply thankful to everyone for their support while I was in such a state. I am glad that I could join forces with the various staff in charge to make progress on RERF's transition to a public-interest incorporated foundation, research ethics reviews, public relations activities, facility repairs of the Hiroshima and Nagasaki laboratories, archiving of historical materials, and other issues involving research and society.

I am pleased to hear that the public lecture presented as part of the 59th Annual Meeting of

the Japanese Radiation Research Society, held on October 26, was successful, because I had requested Mr. Sunao Tsuboi earlier in the spring



Former Executive Director, Mr. Takanobu Teramoto, enjoying nature in Izu-kogen highlands

of this year to speak on behalf of the A-bomb survivors at the event, which was co-sponsored by RERF. During my RERF tenure, I was indebted to many people, and in particular, I appreciated the opportunity to be on friendly terms with Mr. Tsuboi. Longing for world peace and advances in medicine for those exposed to radiation, he was always supportive of RERF research and readily accepted all our requests; I have nothing but respect for him. I dream of a scenario in which Mr. Tsuboi is awarded the Nobel Peace Prize someday based on a recommendation by U.S. President Barack Obama, with whom Mr. Tsuboi shook hands at Hiroshima Peace Memorial Park last May. It would be almost perfect, by the way, if the Hiroshima Carp could win a national baseball title around the same time.

My current home is in the Izu-kogen highlands area, not far from Lake Ippeki, in the city of Ito, Shizuoka prefecture. It is a place surrounded by nature—I rise in the morning to the songs of morning birds (I actually get up earlier than they do). A pheasant family sometimes appears in my garden during the day, and a wild pig family crosses in front of our house almost every night. The best “treat” here is the fresh air arising from the woods.

In their seasons, we can collect edible wild plants, raspberries, and chestnuts. At local fish shops, we can inexpensively buy many kinds of fish in season. We had our home built more than 20 years ago, but this is the first time we will have taken up residence year-round. If we were to admit to inconveniences, we might come up with a few, such as there being nearby no supermarket, general hospital, or department store. However, my family and I are very happy with our life in Ito amidst nature.

I am writing this article from Geneva, Switzerland, where I am on business. A meeting of the Governing Body of the International Labour Organization (ILO) is being held here, and I am a member of one of the ILO committees, the Freedom of Association Committee. I have served RERF for 11 years and this committee of the ILO for eight, making me realize that my involvement with both organizations has continued for quite some time.

The more I talk with local people in Izu, the more attached I feel to the area. Even so, I will think of everyone in Hiroshima and Nagasaki each August 6 and 9. I wish RERF research the very best of success into the future, and hope that someday the organization is awarded the Nobel Prize in Physiology or Medicine. (November 1, 2016)

## ICRP-RERF Joint Meetings Held in Hiroshima and Tokyo “Very Good for Science”

During the period October 6–9, 2016, RERF convened joint meetings at the Hiroshima Laboratory and Tokyo University (working language: English), in partnership with the International Commission on Radiological Protection (ICRP), a body founded in 1928 to provide recommendations and guidance worldwide on radiation protection.

The agenda in Hiroshima at the RERF Auditorium for the first two days—October 6 and October 7—included both joint meetings with RERF as well as independent closed meetings of the ICRP Task Group (TG) 91 (Radiation Risk Inference at Low-dose and Low-dose Rate Exposure for Radiological Protection Purposes) and the ICRP TG 102 (Detriment Calculation Methodology).

On October 8, an informal exchange seminar featuring young RERF scientists with ICRP senior researchers was held first thing in the morning. The recruitment and training of younger research staff members is one of RERF’s most urgent concerns. Its aim in holding this portion of the meetings was to encourage communication between RERF younger researchers and ICRP senior scientists. Dr. John B. Cologne, Senior Scientist, Department of Statistics, said about his interpretation of the seminar, “ICRP people seemed to perceive it as not just

[about] young scientists but also the current and future work of RERF.”

The morning session of the informal seminar included presentations by three younger RERF researchers. Dr. Atsuko Sadakane, fixed-term Research Scientist, Department of Epidemiology, touched on “Impact of medical radiation exposures on the risk estimate analysis of atomic bomb radiation.” Subsequently, Dr. Ritsu Sakata, Senior Scientist, Department of Epidemiology, made a presentation titled “Health effects of black rain in Hiroshima and Nagasaki,” and Dr. Ikuno Takahashi, Associate Senior Scientist, Department of Clinical Studies, talked about “Heart disease mortality among atomic bomb survivors.” The second part of the morning session also had three speakers from RERF. Dr. Misa Imaizumi, Chief, Division of Radiology, Department of Clinical Studies (Nagasaki), spoke on the issue of “Thyroid disease among atomic bomb survivors.” Next, Dr. Kyoji Furukawa, Associate Senior Scientist, Department of Statistics, gave a presentation titled “Development of statistical approaches to radiation risk assessment with atomic bomb survivors,” followed by Dr. Kanya Hamasaki, Research Scientist, Cytogenetics Laboratory, Department of Molecular



Biosciences, who touched on “Fetal irradiation and research risk: Dependence on irradiation stage for persistent cytogenetic damage.”

After a lunch break, ICRP Task Group chairpersons made presentations. ICRP’s Dr. Werner Rühm, Head of Working Group, Institute of Radiation Protection, described the ongoing efforts of TG 91 on the theme “Radiation Risk Inference at Low-dose and Low-dose Rate” and discussed various issues related to the risk of low doses and low-dose rates. Dr. Nobuhiko Ban, Commissioner, Nuclear Regulation Authority, Japan, talked about the activities of TG 102 regarding “Detriment Calculation Methodology” to calculate “detriment” as a measure of disease severity in terms of lethality, impact on quality of life, and years of life lost.

The last session of the day featured as speaker Mr. Mitsuo Kodama (84), an A-bomb survivor who authored a book on his A-bomb experiences titled “Hibakusha A-bomb Survivor—Eight-fifteen a.m. August 6, 1945.” He gave a presentation titled “An atomic-bomb survivor exposed at an extremely short distance: a history of my life,” touching on his experiences resulting from the atomic bombing of Hiroshima and greatly moving the audience. The talk included his descriptions of his exposure 800 meters from the hypocenter in Hiroshima and being only one of 19 students from among more than 300 in the first grade of his junior high school who were able to return to school. He was 12 at the time.

Mr. Kodama’s publication was distributed to the meeting participants beforehand, and immediately following his presentation, 10–15 people lined up to speak with Mr. Kodama and ask for his autograph. According to Dr. Cologne, the gratitude that RERF consistently expresses to the survivors for their cooperation in the organization’s studies takes on new meaning, “because I now have a better understanding of what the survivors went through.”

Mr. Kodama was also invited by Chairman Niwa to speak at the 22nd Biennial Meeting of the Conference on Radiation & Health, in partnership with the 62nd Annual Meeting of the Radiation Research Society, held in Hawaii, October 15–19 (see related article, page 12), which many RERF scientists attended.

The University of Tokyo, the following day, October 9, hosted the “Joint RERF-ICRP Workshop on Health Risk of Radiation and the System of Radiological Protection.” The Tokyo workshop, opened by Dr. Christopher Clement, Scientific Secretary, ICRP, was open to the public and media, attracting more than 80 participants to listen to lectures provided by ICRP members and RERF researchers.

From RERF, Dr. Nori Nakamura, Consultant, Department of Molecular Biosciences, spoke about “Hereditary effects of radiation in men and in mice.” Dr. Eric J. Grant, Associate Chief of Research, spoke on “Dose response of solid cancer in atomic bomb survivors,” which was followed by a talk by Dr. Rühm titled “Current ICRP stance on DDREF.” Later, Dr. Kotaro Ozasa, Chief, Department of Epidemiology, gave a presentation titled “Current research on non-cancer diseases in atomic bomb survivors,” which was followed by Dr. Tamara Azizova (ICRP), Deputy Director, Southern Urals Biophysics Institute (SUBI), speaking on “Circulatory disease in Mayak workers.”

These lectures culminated in a roundtable discussion on “Futures of Health Risk Research and the System of Radiological Protection,” chaired as discussion leaders by Dr. Robert L. Ullrich, RERF Vice Chairman, and Dr. Ban.

ICRP is a body founded in 1928 to provide recommendations and guidance worldwide on radiation protection. It is an independent international, non-governmental organization registered as a charity in the United Kingdom with its scientific secretariat located in Ottawa, Canada, and has more than 200 volunteers—leading scientists and policy makers in the field of radiation protection—from around 30 countries.

These joint meetings in Hiroshima and Tokyo had the effect of introducing the respected international organization to the younger scientists at RERF, as well as affording RERF the opportunity, in collaboration with ICRP, to raise RERF’s profile outside of Hiroshima and Nagasaki, in Tokyo. According to RERF Chairman Niwa, open and instructive communication took place over the course of the four days. He said, “This kind of meeting is very good for science.”

## Seventh Epidemiological Training Workshop for Biologists Draws Capacity Crowd, to RERF's Delight

**Ritsu Sakata**  
Senior Scientist  
Department of Epidemiology, Hiroshima

The seventh Epidemiological Training Workshop for Biologists, sponsored by the Council of Radiation Effects Research Organizations,\* was held at the Hiroshima RERF Auditorium August 29–30, 2016. In addition to the 48 participants from outside organizations, many RERF staff also attended the workshop and helped to make it a success.

This workshop featured a new session, “Biology for non-specialists I,” in the morning program on the first day, with Dr. Asao Noda, Assistant Chief, Department of Molecular Biosciences, serving as the speaker. Dr. Kotaro Ozasa, Chief, Department of Epidemiology, and Dr. Ohtsura Niwa, RERF Chairman, then delivered opening remarks to kick off the workshop.

Lectures on RERF’s epidemiological research and its results were presented first, including “Epidemiology for non-specialists” by Dr. Sakata; “Recent results from the Life Span Study (LSS)” by Dr. Ozasa; and “Risk of heart diseases” by Dr. Kazunori Kodama, RERF Chief Scientist. Following these lectures, Dr. Nori Nakamura, Consultant, Department of Molecular Biosciences, gave a lecture titled “Genetic effects of radiation: why are they undetected in humans?” to conclude the morning session.

Participant self-introductions, scheduled during lunchtime, had to be canceled, because the large number of participants made getting to everyone

difficult.

In the afternoon, the following lectures were delivered:

- “Radiation exposure and thyroid cancer” (Dr. Misa Imaizumi, Chief, Divisions of Radiology and Clinical Laboratories [concurrent assignment], Department of Clinical Studies, Nagasaki)
- “Is cancer susceptibility high among those exposed to radiation at a young age?” (Dr. Atsuko Sadakane, Acting Chief, Laboratory of Pathology, Department of Epidemiology)
- “Radiation’s effect on the fetus: an unresolved issue” (Dr. Kanya Hamasaki, research scientist, Department of Molecular Biosciences)
- “Mechanism of radiation-induced leukemia” and “Introduction to mutual understanding of mouse experiments and epidemiological research” (Dr. Nakamura)

Most participants also attended the reception party, which began with greetings by Vice Chairman Dr. Robert L. Ullrich and Dr. Kiyohiko Mabuchi, Senior Scientist, U.S. National Cancer Institute (NCI). Participants stayed until late in the evening enjoying conversation.

On the second day of the workshop, the morning session began with “Radiobiology for non-specialists II” by Dr. Nakamura. This presentation was followed by “Tissue-specific variance of naturally occurring cancers” (introduction of

Tomasetti paper), in which Dr. Munechika Misumi, Research Scientist, Department of Statistics, explained the statistical models used in the paper. The next presentations were “How should epidemiology and biology be connected?” by Dr. Mabuchi and “Radiation carcinogenesis and stem cells” by Dr. Niwa. After the lectures, a general discussion was held to conclude the workshop.

In his lecture, Dr. Nakamura explained that the workshop was initiated on the basis of his own difficulties in understanding RERF’s epidemiology publications and because he thought biologists in other organizations



Scene of training workshop at Auditorium, with Dr. Ritsu Sakata, Senior Scientist, Epidemiology Dept., giving a lecture (at rear left)

would face similar difficulties, as they were likely not in regular contact with statisticians or epidemiologists.

To this 2016 workshop, we were able to attract a broader range of participants due to the Japan Health Physics Society's efforts to publicize the event. Participation of those in varied fields and from different backgrounds is welcome from the viewpoint of enhancing participant exchange and having discussions from varied viewpoints. On the other hand, by preparing training and lectures focused on the participants' various fields and backgrounds, the program is starting to feel overloaded. We may have to review our program preparation and think about modifications, such as making the basic lectures more compact in the future.

RERF technicians also participated in this year's workshop. We hope that the event was helpful for them to reaffirm the mission of RERF and review scientific basics of their work. In conclusion, I would like to thank the participants, lecturers, and staff of the General Affairs Section and the Department of Epidemiology involved in the preparations for making this workshop a success.



Workshop program

\*The Council of Radiation Effects Research Organizations, consisting of the Institute for Environmental Sciences, Kyoto University, Nagasaki University, Hirosaki University, Hiroshima University, Fukushima Medical University, National Institute of Radiological Sciences, and Radiation Effects Research Foundation (order arranged according to the Japanese syllabary), was established to develop understanding and association among radiation research organizations.

## 22nd Biennial Meeting of the Conference on Radiation and Health Held in Hawaii—RERF and Mitsuo Kodama, A-bomb Survivor, Participate

Eric J. Grant  
Associate Chief of Research

The 22nd Biennial Meeting of the Conference on Radiation & Health (CRH), in partnership with the 62nd Annual Meeting of the Radiation Research Society (RRS), was held on the Big Island of Hawaii October 16–19, 2016, with the CRH Early Stage Radiation Investigators (ESRI) Workshop convened on October 15, 2016.

The CRH, formerly sponsored by the American Statistical Association, began meeting jointly with the RRS Annual Meeting in 2014. The CRH topics tend to focus more on epidemiological, radiation protection, and dosimetric issues, while the RRS topics tend to focus on the laboratory science of radiation biology and on clinical radiation therapy. Some sessions are specifically designated as “joint”



Scene of annual meeting



gatherings that provide opportunities for topics that intersect these areas of research. The concurrent meetings allow attendees to freely move between sessions and obtain a broad understanding of the current issues in radiation research.

On the first day, October 15, Dr. Harry M. Cullings, Chief, RERF Department of Statistics, chaired a session on “Dosimetric Uncertainties” that explored radiation dose estimation in the Kazakhstan, Techa River, and Mayak worker cohorts, along with statistical methodologies to account for any uncertainties in the dose estimates when they are used as the independent variable in risk regressions. The next morning, October 16, a major CRH session was titled “RERF” and included five speakers, four of whom were current RERF researchers. Dr. Eric J. Grant, Associate Chief of Research, spoke on “Cancer epidemiology of atomic bomb survivors” and included some historical topics, including the Atomic Bomb Casualty Commission (ABCC; RERF’s predecessor organization)’s sometimes unfavorable treatment of A-bomb survivor study participants prior to the establishment of RERF; some in attendance mentioned their appreciation for his forthrightness. Dr. Cullings then spoke on “Atomic bomb survivor dosimetry,” which detailed recent upgrades to RERF dose estimates under the moniker “DS02R1.” Dr. Nori Nakamura, Consultant, Department of Molecular Biosciences, later discussed the work done at RERF on hereditary effects of radiation over the long history of ABCC and RERF. Dr. Kazunori Kodama, Chief Scientist, discussed RERF’s current efforts on development of its Biosample Center and how the organization hopes the Center will lead to greater opportunities for collaboration with external researchers and institutes in the future.

The highlight of the session (and perhaps the

entire conference) was a presentation by Mr. Mitsuo Kodama (84), an A-bomb survivor, titled “An atomic bomb survivor exposed at an extremely short distance: a history of my life.” Mr. Kodama’s talk touched on his experiences resulting from the atomic bombing of Hiroshima, greatly moving the audience, some of whom were interviewed on the spot by a reporter from the New York bureau of NHK, the national public broadcaster in Japan. Mr. Kodama was invited to speak at the event by Dr. Ohtsura Niwa, RERF Chairman (see separate article on Mr. Kodama’s talk to ICRP, page 9), with the aim of providing researchers the opportunity to interact with a survivor and learn of his experiences. Mr. Kodama’s talk included descriptions of his exposure 800 meters from the hypocenter in Hiroshima and being only one of 19 students from among more than 300 in the first grade of his junior high school who were able to return to school. He was 12 at the time. He touched on the point that he and others of his male friends were unable to father children, and believed that his radiation exposure was to blame, as well as on the multiple cancers he has suffered. He listened politely to all the scientists’ lectures but cautioned the researchers in the room not to prematurely discount possible hereditary effects among those born to atomic bomb survivors.

Mr. Kodama authored a book on his A-bomb experiences titled “Hibakusha A-bomb Survivor—Eight-fifteen a.m. August 6, 1945,” which was distributed to the meeting participants beforehand. Immediately following his presentation, many attendees lined up to speak with Mr. Kodama and ask for his autograph on their book copy. The opportunity to meet and listen to the stories of one of the A-bomb survivors who have been studied for decades at ABCC and RERF gave radiation experts a human perspective from which to view their research into radiation health effects.

A poster session that evening of October 16 was well represented by a number of RERF researchers, who displayed their research on the risks for various body tissues in response to radiation exposure, the results of which are currently being prepared for publication.

On October 19 was held a joint RRS/NIAID symposium titled “Late effects of radiation injury and the dominoes continue to fall,” featuring Dr. Tomonori Hayashi, Assistant Chief, RERF Department of Molecular Biosciences, as speaker. His presentation, titled “Influenza vaccine response in 2011–2013 among Hiroshima’s atomic-bomb survivors,” touched on analysis results of the vaccination immune response in the RERF survivor population.



Mr. Mitsuo Kodama speaking of his A-bombing experience

Other sessions at CRH included Occupational Studies, Topical Review of Controversies in Thyroid Cancer Screening, Disaster Consequences and Emergency Preparedness, Radiation Genetics, and a special symposium on Low-Dose Epidemiology in honor of the late Dr. William F. Morgan, a leading figure in the study of biological effects of ionizing radiation. The CRH ended with a banquet at which Dr. Ruth Kleinerman of NIH was the speaker and Dr. Marilyn Stovall of University of Texas Health Science Center was honored for her lifetime contribution to radiation dosimetry.

In addition to these sessions, the meeting in Hawaii explored such topics as: increased cancer risk amid an increasing global population, radiotherapy's prominent role in the control and eradication of various types of cancers, and the idea that the future success of radiotherapy depends on a fundamental understanding of radiation effects at the biophysical, radiochemical, molecular, and tissue specific levels. The theme of occupational and environmental exposures contributing to secondary radiogenic cancers highlighted the need to understand the detailed effects of ionizing radiation exposure on biology. In addition, improved disease

detection and therapy using radiation will improve patient outcomes and quality of life for cancer survivors and help in reducing health-care costs.

The annual meeting represents an opportunity for radiation science researchers to discuss new ideas and findings. The meeting featured a comprehensive scientific program, including world-class plenary speakers, two debate sessions, and five interdisciplinary symposia and workshops covering state-of-the-art radiological sciences with an emphasis on neuroscience. New this year was the inclusion of continuing medical education credits for certain scientific sessions, enhancing the meeting's educational objectives.

The Radiation Research Society's objectives are, according to the organization: advance radiation research in all areas of the natural sciences; facilitate cooperative research among disciplines regarding the study of properties and effects of radiation; and promote dissemination of such disciplines through publications, meetings, and educational symposia.

The next CRH/RRS joint meeting is scheduled for October 2018 in Chicago, U.S. Dr. Grant will be a scientific co-chair for the meeting.

# Irradiation at different fetal stages results in different translocation frequencies in adult mouse thyroid cells\*

Kanya Hamasaki

Department of Genetics

\*This article is based on the following publication:

Kanya Hamasaki, Reid D. Landes, Asao Noda, Nori Nakamura, Yoshiaki Kodama: Irradiation at different fetal stages results in different translocation frequencies in adult mouse thyroid cells. *Radiat Res* 2016 (October); 186(4):360-6 (doi: 10.1667/RR14385.1)

## Study Findings

We examined chromosome aberration frequencies in thyroid tissues of adult mice irradiated during the fetal stage and found that radiation effects varied depending on the fetal stage at the time of irradiation. While mice irradiated as 6.5-day fetuses (before organogenesis) had a relatively low chromosome aberration frequency ( $5.8 \times 10^{-3}$ ), adult mice irradiated as 15.5-day fetuses (during the fetal stage) showed frequencies that were nearly the same as that of their mothers' ( $25.3 \times 10^{-3}$ ). Taking into account findings from previous studies, we interpreted these results as an indication that fetal tissue stem cells record radiation damage primarily when exposed after locating in their niche\*; before locating in their niche, however, radiation-damaged cells may undergo negative selection and be unable to locate in the niche, and therefore the effects of radiation damage may not remain.

Niche\*: Microenvironment in which tissue stem cells can function.

## Explanations

Based on findings from epidemiological studies (case-control studies) starting in the 1950s, fetuses have been considered highly sensitive to cancer risks from radiation. However, RERF's study using chromosome aberration frequency in lymphocytes as a marker revealed that few effects of radiation were observed among in-utero survivors. The present study investigating chromosome aberrations in tissues of mice irradiated as fetuses may provide a clue for understanding these apparently contradictory observation results.

### 1. Study Purpose

To verify differences in fetal irradiation-related chromosome aberrations among tissues of different types, we previously studied hematopoietic cells in

mice and mammary gland epithelial cells in rats. In this study, we examined chromosome aberration frequencies in mouse thyroid epithelial cells. We also conducted experiments using irradiation at different stages of fetal development to determine whether or not chromosome aberration frequencies following fetal irradiation differ by when irradiation occurs.

### 2. Study Methods

Pregnant female mice were irradiated with 2 Gy of X-rays at day 6.5 or 15.5 after conception. After the neonatal mice reached adulthood (at least eight weeks of age), their thyroid glands and those of their mothers were removed. We cultured thyroid epithelial cells for five or six days and prepared chromosome samples using conventional methods. To detect stable chromosome aberrations, such as translocation, occurring in thyroid cells due to fetal irradiation, we employed fluorescence in situ hybridization (FISH),\* which labels chromosomes 1 and 3 in green and red, respectively. We then observed slides of labeled chromosomes and counted the number of translocations and other stable chromosome aberrations. In a portion of the mice, spleen T lymphocytes were also cultured and assessed for chromosome analysis.

\*FISH (fluorescence in situ hybridization) is a staining technique. To determine the presence or absence of structural abnormality in a target chromosome (chromosomes 1 and 3 in this study), DNA is extracted from a library of the target chromosome and labeled with fluorescence to prepare a probe. (A library contains DNA extracted from individual chromosomes and amplified in *Escherichia coli*.) Following preparation of single-strand DNA from double-strand DNA of the target chro-



mosome sample (denaturalization), a reaction is prompted with the aforementioned probe (hybridization), making it possible to label a specific DNA sequence artificially.

### 3. Study Results

- (1) Adult mice irradiated with 2 Gy of X-rays as 15.5-day fetuses had a higher translocation frequency (30/1155 or  $25.3 \times 10^{-3}$ ) in thyroid cells than did non-irradiated adult controls (0/1007 or  $0.1 \times 10^{-3}$ ), a figure that was nearly the same as that experienced by irradiated mothers and other adult females (43/1244 or  $33.6 \times 10^{-3}$ ). These results are consistent with previously observed results in fetally irradiated rat mammary cells.
- (2) When fetuses were exposed to 2 Gy at an earlier stage of development (day 6.5) before thyroid organogenesis, however, the resulting translocation frequency was much lower (3/502 or  $5.8 \times 10^{-3}$ ) than that in the mice irradiated at day 15.5 (30/1155 or  $25.3 \times 10^{-3}$ ). These results reveal that fetal radiation sensitivity differs by timing of irradiation, and

that the effects of thyroid irradiation prior to thyroid organogenesis are insignificant. On the other hand, few chromosome aberrations were observed in hematopoietic tissues regardless of the timing of irradiation (it is understood that hematopoietic stem cells locate in their niches only after birth).

### Study Significance

This study revealed that chromosome aberration frequencies in mouse thyroid cells due to fetal irradiation differed by timing of irradiation (prior to organogenesis/during the fetal stage). Such differences may be partly attributed to whether or not irradiated tissue stem cells have located in their niche. If tissue stem cells are irradiated before locating in this way, aberrant cells cannot locate in their niche; when such cells are irradiated after locating in their niches, however, stem cells may repair DNA damage with the aim of survival, and thus cause mis-repairs of DNA that lead to chromosome aberrations. This study's results will contribute to understanding of the mechanisms behind cancer risks due to fetal radiation exposure.

## Relationship between spontaneous $\gamma$ H2AX foci formation and progenitor functions in circulating hematopoietic stem and progenitor cells among atomic-bomb survivors\*

Junko Kajimura

Department of Radiobiology/Molecular Epidemiology

\*This article is based on the following publication:

Junko Kajimura, Seishi Kyoizumi, Yoshiko Kubo, Munechika Misumi, Kengo Yoshida, Tomonori Hayashi, Kazue Imai, Waka Ohishi, Kei Nakachi, Nan-ping Weng, Lauren F. Young, Jae-Hung Shieh, Malcolm A. Moore, Marcel R.M. van den Brink, Yoichiro Kusunoki: Relationship between spontaneous  $\gamma$ H2AX foci formation and progenitor functions in circulating hematopoietic stem and progenitor cells among atomic-bomb survivors. *Mutat Res Genet Toxicol Environ Mutagen* 2016 (May); 802:59-65 (doi: 10.1016/j.mrgentox.2016.03.007)

### Study Findings

The self-renewability of hematopoietic stem cells has been suggested to decline in atomic bomb (A-bomb) survivors exposed to higher radiation doses and who had more DNA damage in their hematopoietic stem and progenitor cells (HSPCs),

which are responsible for the production of red, white, and other blood cells.

### Explanation

#### 1. Study Purpose

Accumulation of DNA damage in hematopoi-

etic stem cells is known to be one factor in the functional decline of human hematopoiesis associated with aging. Not known, however, is whether an association exists between radiation exposure and hematopoietic decline due to accumulated DNA damage. This study examined the association between radiation exposure and hematopoietic function by measuring DNA damage frequency in the circulating HSPCs of A-bomb survivors.

## 2. Study Methods

Using peripheral blood collected from 229 consenting A-bomb survivors in Hiroshima who participated in the Adult Health Study (AHS) from 2011 to 2013, we evaluated DNA damage frequency using  $\gamma$ H2AX foci formation\* as a marker. Also assessed was hematopoietic function including self-renewability of HSPCs, which can be detected by the cobblestone area-forming cell\*\* assay in CD34-positive/lineage marker-negative (CD34+Lin-) HPSCs. In addition, we measured the length of granulocyte telomeres\*\*\* as a marker for the assessment of hematopoietic system aging.

**\* $\gamma$ H2AX foci formation:** In the presence of DNA damage such as DNA double-strand breaks,  $\gamma$ H2AX and other DNA repair proteins form a mass called a “focus” at the break. By detecting such foci and ascertaining their numbers, DNA damage frequency can be determined.

**\*\*Cobblestone area-forming cell:** When a cell-culture environment is created *in vitro* similar to one in which hematopoietic stem cells self-renew in the bone marrow (culturing HSPCs in the absence of hematopoietic factors and in the presence of stromal cells), hematopoietic stem cells form an undifferentiated cobblestone-like colony, allowing assessment of how many hematopoietic stem cells have self-renewability.

**\*\*\*Length of granulocyte telomeres:** Cellular telomere length is a marker used to assess aging because length of a telomere, a repeat base sequence located at the end of a chromosome, is shortened at each cell division. The length of granulocyte telomeres is a marker to assess aging of the entire hematopoietic system, because granulocytes have a short lifecycle of a few days *in vivo* and are

continuously produced from hematopoietic progenitor cells.

## 3. Study Results

### (1) Frequency of DNA damage in HSPCs in association with radiation dose

DNA damage frequency ( $\gamma$ H2AX foci formation) gradually decreased with increasing radiation dose up to 1.5 Gy. At higher doses, an increase in foci was observed. Because DNA damage detected on the basis of  $\gamma$ H2AX foci can be repaired within a few days, detected DNA damage may have been induced by oxidative stress *in vivo* over the period of a few days before blood drawing rather than by A-bomb radiation. The association observed in this study with radiation dose may indicate lower levels of DNA damage stress or more effective DNA repair among A-bomb survivors exposed to 1.5 Gy or less. Such details are unclear at this point in time.

### (2) Frequency of DNA damage in HSPCs in association with granulocyte telomere length

Frequency of  $\gamma$ H2AX foci formation increased with decreasing length of granulocyte telomeres, which suggests an association between DNA damage in HSPCs and aging of the hematopoietic system. A similar association has been reported by other studies. In this study, the association with aging was also confirmed in A-bomb survivors.

### (3) An interaction effect between radiation dose and frequency of DNA damage

A negative interaction effect between radiation dose and  $\gamma$ H2AX foci formation frequency was indicated in the cobblestone formation assay. This result suggests that the self-renewability of hematopoietic stem cells may have decreased among survivors who had a higher radiation dose and more DNA damage.

## Study Significance

Many years after radiation exposure and as the A-bomb survivors continue to age, their hematopoietic functions as a group show normal aging, but this study suggests that among A-bomb survivors with large quantities of accumulated DNA damage in HPSCs, reduced self-renewability of hematopoietic stem cells due to aging may be modified by A-bomb radiation exposure.

## In Memoriam

### Dr. Seymour Abrahamson

(November 28, 1927–July 23, 2016)

Dr. Seymour Abrahamson, Professor Emeritus of Zoology at the University of Wisconsin–Madison, died in Madison, Wisconsin, U.S., July 23, 2016, at the age of 88.

He was born in New York City on November 28, 1927, and received his Ph.D. in genetics from Indiana University, where he studied under the Nobel Laureate geneticist Dr. Herman J. Muller. Dr. Abrahamson joined the U.W.-Madison faculty in 1961, teaching classes on zoology and genetics. He also supervised a genetics research laboratory studying radiation effects in *drosophila*. He twice served as Chair of the Zoology Department at the university.

In addition to his academic career in the United States, Dr. Abrahamson served in various posts at RERF, helping oversee and publish studies regarding radiation effects in atomic bomb survivors. During 1988–1990, he served as Permanent Director and Chief of Research, and again in the same posts 1992–1994. During 1995–1996, he worked as Vice Chairman and Chief of Research and in the latter months as Permanent Director. In 1998, he acted as Associate Chief of Research and during 2000–2001 again served as Vice Chairman and Chief of Research. For his contributions to science and the Japanese people, Dr. Abrahamson received a distinguished service award from the Emperor of Japan in 1999.

Dr. Abrahamson, the recipient of many other honors, was elected to five professional societies, including the American Association for the Advancement of Science, and served on numerous professional boards and committees on the state, national, and international levels, among them the National Academy of Sciences, National Council on Radiation Protection, Nuclear Regulatory Commission, Environmental Protec-



Dr. Seymour Abrahamson, November 2000, at Hiroshima RERF

tion Agency, Brookhaven National Laboratory, Argonne National Laboratory, and Institute of Regulatory Sciences.

Dr. Abrahamson published more than 100 papers and book chapters in scientific journals involving health, physics, and radiation, participated on the editorial boards of several professional publications, and served as Editor-in-Chief of *Environmental Mutagenesis*.

RERF would like to offer its condolences to Dr. Abrahamson's wife, Wisconsin Supreme Court Justice and former Chief Justice Shirley Abrahamson, as well as extended family, and express our heartfelt appreciation for his significant contributions to the field of radiation health effects research over so many years, including the research conducted at RERF.



## In Memoriam

### Dr. Charles Wendell Edington

(February 26, 1925–September 17, 2016)

**Evan B. Douple**  
Former Associate Chief of Research, RERF

It is with much sadness that I report the passing of Dr. Charles Wendell Edington, former RERF Vice Chairman, who died in his favorite reading chair in his home in New Bern, North Carolina, U.S., September 17, 2016, at the age of 91.

“Charlie” reinforced my interest in, and respect for, the important work being done at RERF. When exploring the possibility of a sabbatical in Washington, D.C., I was invited by Dr. Edington to assist his staff at the National Academy of Sciences (NAS) Board on Radiation Effects Research (BRER). I will always remember his big smile and “southern gentleman” welcome. On his office wall was a large chalkboard with numbers in many columns. When I inquired about the figures, he said he was tracking the daily Japanese yen/U.S. dollar exchange rate to get the most favorable exchange for dollar funding from the U.S. government to RERF—an example of his attention to detail, fairness, and support for RERF.

Charlie was born February 26, 1925, in Knoxville, Tennessee, U.S., and raised on a farm during the Great Depression. He was awarded B.S., M.S., and Ph.D. degrees in zoology from the University of Tennessee. He began his career in genetics and studied the biological and medical effects of radiation at the Biology Division of Oak Ridge National Laboratory. He taught at Florida State University. His interests in genetics continued when he moved to the U.S. Atomic Energy Commission (AEC), at which he was promoted to Associate Director of the Office of Health and Environmental Research, U.S. Department of Energy, 1981–1985. He left DOE to work at NAS and was appointed to serve as RERF Vice Chairman, 1985–1987. Because of his experience and training in genetics, Dr. Edington took great interest in RERF biological research and genetics work.

While residing in Japan, Charlie and his wife Suzanne made many friends. A “red meat” person not fond of sashimi, Charlie discovered that the chef of the sushi restaurant Sushitomi on the east side of Hijiyama had been trained in a famous western-style steak restaurant; thereafter, the couple was frequently seen eating in Sushitomi and sharing Charlie’s “Tennessee sake” (Jack Daniels) with the neighborhood “locals.”

After returning to the U.S., Charlie served as Director of BRER where he continued to support RERF through dedicated work. In a book Charlie recommended about Atomic Bomb Casualty Commission (ABCC; predecessor to RERF) history, I read of the U.S. intent to get Japan back on its feet quickly following the war by encouraging Japan to re-establish medical infrastructure on its own. There were also accounts that U.S. medics individually would make special arrangements to provide medical assistance when needed. Last month, in the New Bern obituary, I read: “When Charlie was a Japanese-language interpreter with an Army medical unit during the occupation of Japan, he bent the rules to help ensure that a young Japanese schoolgirl got the medical care she needed to survive a dangerous infection. Back in Japan some 30 years later, he met the girl, Tomoko, again, as well as her family.”

Of course—that was Charlie Edington as I remembered him, always kind, fair, helpful and considerate of others. I would like to offer my condolences to Dr. Edington’s family and express my heartfelt appreciation for his significant contributions to the research conducted at RERF.



Dr. Charles Edington, July 1987, at Hiroshima RERF

## Report on NEWS (3rd in series)

# RERF Epidemiological Study of Health Effects in Fukushima Emergency Workers

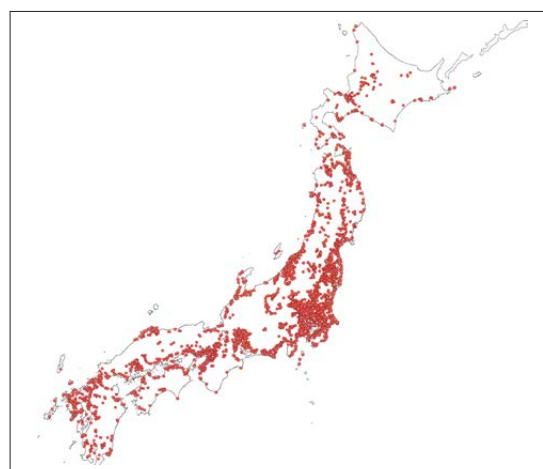
**Toshiteru Okubo**  
NEWS Principal Investigator  
RERF Senior Consulting Scientist

This is the third in a series of reports, following the second report, which appeared in the Summer 2016 issue of *Update*. In this article, I will look into such issues as how we manage study participants dispersed across every prefecture in Japan. NEWS (Nuclear Emergency Worker Study), as the title implies, is an acronym for the official Epidemiological Study of Health Effects in Fukushima Emergency Workers.

## NFIHO member organizations act as collaborating centers throughout Japan

Since Fukushima emergency workers are scattered across every one of Japan's prefectures (see map at right), it has been necessary for us to establish centers for conducting interviews and health examinations throughout Japan. For this purpose, we contacted mainly member organizations of the National Federation of Industrial Health Organizations (NFIHO), which are entrusted with workers' health examinations. As a result of this effort, 61 NFIHO organizations, including NFIHO branches, became collaborating organizations.

We have asked each of these organizations to appoint one or two nurses as research coordinators (RCs) to be in charge of coordinating study-related work. On March 14–15, 2015, we held the



Current location of the nearly 20,000 Fukushima emergency workers, who are spread throughout all 47 prefectures of Japan, including Okinawa (not shown on map; as of December 2014)

first RC meeting in Tokyo to provide training on epidemiological approaches that RCs would need to understand in order to conduct interviews and health examinations for the emergency workers. The meeting program featured presentations on radiation health effects, basic knowledge in data management, and the role of the RC, in order to lay the groundwork for the study.

In addition to the RC meeting, we held a meeting on July 5, 2015, for those in charge of administrative work of the collaborating organizations, since administration of financial requests and payments is also important for conducting the study.

We then researched how many health examinees could be accepted for individual visits to the collaborating organizations, and held the following seminars on special examination techniques.

- Thyroid ultrasound (7/2/15, 11/12/16)
- Structured interview for psychological effects (2/7/16, 2/14/16, 7/9/16, 10/15/16)
- Photomicrography for cataracts (in the planning stage)

Collaborating organizations and study participants in Japan by prefecture

|           |   |      |           |   |     |           |   |     |
|-----------|---|------|-----------|---|-----|-----------|---|-----|
| Hokkaido  | 1 | 561  | Toyama    | 1 | 16  | Shimane   | 1 | 78  |
| Aomori    | 1 | 643  | Ishikawa  | 1 | 60  | Okayama   | 2 | 25  |
| Iwate     | 1 | 112  | Fukui     | 2 | 112 | Hiroshima | 3 | 126 |
| Miyagi    | 2 | 370  | Yamanashi | — | 90  | Yamaguchi | — | 63  |
| Akita     | — | 91   | Nagano    | 1 | 85  | Tokushima | — | 8   |
| Yamagata  | 1 | 50   | Gifu      | 2 | 56  | Kagawa    | — | 55  |
| Fukushima | 2 | 5388 | Shizuoka  | 3 | 263 | Ehime     | 1 | 82  |
| Ibaraki   | 2 | 1021 | Aichi     | 4 | 169 | Kochi     | 1 | 21  |
| Gunma     | 1 | 288  | Mie       | 1 | 59  | Fukuoka   | 4 | 303 |
| Tochigi   | 1 | 216  | Shiga     | 1 | 26  | Saga      | 1 | 73  |
| Saitama   | 1 | 1137 | Kyoto     | 1 | 59  | Nagasaki  | 1 | 139 |
| Chiba     | 1 | 1409 | Osaka     | 1 | 255 | Kumamoto  | 1 | 41  |
| Tokyo     | 6 | 2404 | Hyogo     | 1 | 224 | Oita      | 1 | 43  |
| Kanagawa  | 2 | 2009 | Nara      | — | 10  | Miyazaki  | 1 | 38  |
| Niigata   | 2 | 1244 | Wakayama  | 1 | 27  | Kagoshima | 1 | 44  |
|           |   |      | Tottori   | 1 | 16  | Okinawa   | 1 | 51  |

Numbers of collaborating organizations (middle column) in each Japan prefecture and study participants (right column)

In addition to biochemical tests of blood to be conducted when obtaining blood samples, we plan to preserve part of the blood and urine samples at minus 80 degrees C on a long-term basis, because we intend to confirm retrospectively the onset of changes and development of symptoms regarding any disorders found later. Multiple issues must be resolved before starting collection and preservation of samples on a full-scale basis. One such issue is standardization of the technical approach to treating sample blood among the collaborating organizations, as treatment of these blood samples is different from the normal work of these organizations, which specialize in medical checkups at workplaces. Another matter to be considered is standardized transport of the samples to RERF, where samples will be preserved, from the health-examination centers throughout Japan. For this reason, in FY2015 we limited transport to whole blood at 4 degrees C.

The current study involves many persons and organizations. The approximate number of study participants, 20,000, is not particularly large for this kind of epidemiological project, but the number of their workplaces exceeds 1,000, and the addresses of the workers are scattered nationwide. That is why we have asked about 70 collaborating organizations throughout Japan to conduct interviews and health examinations. In conducting examinations over such a wide network, we cannot help but entrust the handling of personal data to the call centers contacting emergency workers and the sample transport operators. Multiple collaborating researchers and six individual research institutes may actually handle the emergency workers' data. Since this cross-sectional structure of the study is highly likely to change over time, it is important for us to establish an information processing system that has continuity and can cope with changes in the information network. Needless to say, it is also essential to develop a specialized information processing and distributing system equipped with strict confidentiality to ensure that personal information can be communicated without error over such a wide network. We are currently working on developing such a system to satisfy these requirements.

### **Quality control as a key issue to consider in the future**

With the increased upper limit permitted for radiation exposure in emergency work, the national government has directly determined general health-control criteria for all such emergency workers. Setting the national limit as the minimum standard, however, the Tokyo Electric Power Company (TEPCO) and its prime contractors have prepared their own additional services. As a result, a variety

of systems for safety and industrial health management have been established by contractors and corporations. Regarding exposure dose, for example, the limits set by some companies are obviously low compared to the average. For this reason, when conducting our analysis in the current study, we may have to focus not only on dose variance but also on other possible confounding factors, including preliminary education on radiation protection, countermeasures for heatstroke and labor load, and differences in the hotels where the workers stayed.

The urgent task for us at the moment is to solicit participation in the study by as many emergency workers as possible. But based on our past experience, we anticipate a range of problems in addition to differing perceptions among the workers. For instance, many of the study participants still work at a distance from their families, and as a result, if we send mail to their registered addresses, the mail is often received by the workers' family members. In such cases, we will have to contact the workers through their family members to determine the site of the workers' health examinations.

Systematic duplication of health examinations is another issue to consider. Most of the candidate study participants are hazardous operations workers who are eligible for application of special health care under the Industrial Safety and Health Act, and therefore they basically undergo health examinations twice a year (routine examinations and special examinations/examinations for specific task workers). In addition to these examinations, the national government has conducted screenings for cancer, thyroid disorder, and cataracts for these workers, depending on exposure dose; at the same time, the government has established a national network for counseling of the workers. TEPCO has been providing supplementary examinations as well. Because we are adding our study-related examinations in circumstances that involve almost excessive health examinations, we will have to consider the factor of examinee stress. Since we plan to conduct a time-dependent analysis of the results on a long-term basis, an important factor for our study-related examinations will be firm quality control. The frequency of examinations, however, will probably be once every two-to-three years, and one of our major tasks will be to coordinate the timing and frequency of these multiple health examinations and test items, and develop a system that is useful for individual examinees' health control.

### **Importance of building good relationships with the study participants**

In working on invitations to individual emergency workers to participate in our study, we have received inquiries based on workers' concerns



about involvement in hazardous work and the relevant system of benefits. For examination-specific questions, we have received comments and inquiries about the possible costs for detailed checkup or treatment and compensation for potential disease occurrence. If any health disorder is found in our study-related examinations, our project will not be able to bear the costs for additional detailed checkups and further treatment. Some corporations may be able to take care of this issue for those who are still working, but when retirement of the workers increases in the future, such compensation will be more difficult. Even now, non-regular workers, such as those working on a temporary basis, are not financially compensated for time spent in the health examinations, and this has often been cited as a reason for workers refusing to participate in the examinations. Generally speaking, if someone suffers a disease that is deemed eligible for workers' compensation, he/she will have a chance to receive compensation. Even so, compliance with compensation criteria could be an issue. We understand that we should build good relationships with the candidate study participants from the outset and provide them with enough information to prevent conflicts stemming from misunderstandings. Some of those conflicts are exemplified in past legal court cases involving workers' compensation and atomic

bomb diseases.

As much as we try to address these social concerns, our fundamental purpose, as stated above, is to elucidate the health effects of low-dose radiation. To this end, we will attempt to analyze exposure dose as accurately as possible, thus enhancing the reliability of health-effect index measurements, and pay full attention to confounding factors when conducting analysis.

In addition to NEWS, another line of follow-up is ongoing with respect to national government workers, including members of Japan's Self-Defense Forces, firefighters, and law-enforcement officers who provided emergency help and worked immediately after the accident during the early hazardous time. Incidentally, a considerable number of national and local government workers who must have entered the damaged facility in response to the accident are not included in the scope of emergency workers for NEWS.

Information transfer is vital in the present project, which involves a large number of study participants, collaborating organizations, and research collaborators. The next NEWS article in this series, scheduled to appear in the Summer 2017 issue of Update, will look into the computer system that plays an important role in facilitating this communication.

## Recent Publications

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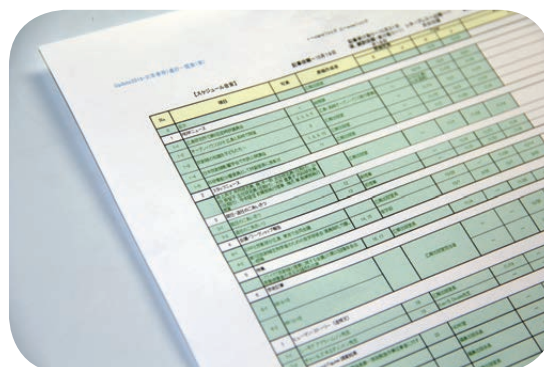
## Editor-in-Chief's Greetings

### Welcome to the *Update* Winter edition of 2016.

This marks my inaugural issue as Editor-in-Chief, after involvement in the publication for years, first as editor/translator and next as technical editor. I will rely on Dr. Eric J. Grant, RERF's Associate Chief of Research, to serve as Scientific Advisor (see his greetings on page 26). I owe a debt of gratitude to Dr. Harry M. Cullings, the previous Editor-in-Chief, for his dedication to the newsletter since the summer of 2013.

My hope for *Update* is that it continues to evolve, with the help of my able colleagues in the Public Relations and Publications Office, into a publication that gives readers a chance to absorb our newest research results and peek into the inner workings of RERF as an organization engaged in work that touches the public in sometimes subtle but significant ways. Our data are used, for instance, in radiation protection standards worldwide, as well as in Fukushima in 2011, when the Japanese national government had to devise guidelines for evacuation from affected areas and for emergency nuclear workers working to control the crisis (see our NEWS series on page 20). My challenge with *Update* is to shine light on the importance of RERF work, work that would be impossible without cooperation from the A-bomb survivors of Hiroshima and Nagasaki.

I have resided in Japan for nearly two decades, most of that time in Hiroshima. The impression the



Busy *Update* work schedule for 2016 Winter edition

atomic bombings left on Hiroshima and Nagasaki is indelible. I often wonder whether the cities could ever emerge from that history with their innocence restored. I also am aware, however, of the important roles that those cities alone can play in the world precisely because of their experience. RERF shares with the world the knowledge it has learned concerning radiation health effects from survivors of the atomic bombings of the two cities. I am proud to contribute my part to that effort.

My two children, with guidance from their Japanese mother, attend local schools. I am grateful for the safe environment in which they can learn and grow. I am hopeful they will become adults with pride in this city in which they were born



New Editor-in-Chief Jeffrey Hart (2nd from left) and Technical Editors Yutaka Ogasawara (left), Sayaka Green (2nd from right), Jun Kitamura (right), with copy of new *Update* cover in Hijiyama Hall garden

and raised and that the experience provides them a platform from which to speak on important issues of our time.

This year, 2016, was marked by memorable events: Hiroshima hosted its first-ever visit by a sitting U.S. president, Barack Obama, in May, something that Dr. Cullings touched on in previous greetings (see Summer edition *Update* 2016). The Olympics in Rio were, as always, awe-inspiring; Japanese athletes won 41 medals, their best showing ever. The Hiroshima Carp baseball team made it to the championship series—after winning the Central League pennant for the first time in 25 years—only to be defeated in 6; no more of that issue shall be spoken here. In the U.S., the Cubs won the World Series after a century-plus. The presidential election captured even Japan's attention; when visiting Hiroshima University High School to speak on English scientific writing, I was approached by a security guard who discussed his take on the election and its global implications (my teaching experience will appear in the next *Update*). Scientifically, RERF submitted since

the last *Update* the newest paper on its seminal longitudinal study of solid cancer incidence in the A-bomb survivors (to be touched on next issue). In November, we published a paper on differences found in mutation frequency in mice depending on fetal stage of irradiation (see page 15). Another paper looked at gene foci formation and progenitor functions in blood among atomic bomb survivors (see page 16). In addition, for younger generations, RERF initiated an effort to communicate about radiation in a new School Visit program (see page 4).

I spend considerable time trying to bridge cultural and linguistic differences both at home and at work. *Update*, a bilingual publication, represents a forum for me to apply what I learn to the issue of communicating RERF to the public.

My team and I invite you to enjoy this newest issue and the issues to come.

Jeffrey L. Hart  
Editor-in-Chief

## Scientific Editor's Greetings

Welcome to the latest edition of RERF *Update*. Long-time readers will recognize several changes in this edition. First, is the emergence of Mr. Jeffrey L. Hart as Editor-in-Chief. Mr. Hart serves as Chief of RERF's Public Relations and Publications Office, which has taken on the bulk of the responsibilities in producing *Update*. Readers and staff alike owe a hearty thanks to our most recent Editor-in-Chief, Dr. Harry M. Cullings, who has filled in admirably since the departure from RERF of Dr. Evan B. Douple at the end of 2012. Dr. Cullings will continue to offer advice on *Update* as needed. Finally, I bid you all greetings as the incoming Scientific Editor and will do my best to uphold the fine work performed by so many before me.

I was appointed as RERF's Associate Chief of Research in April 2016. I have worked for RERF since December 1997, most recently as Assistant Chief of the Department of Epidemiology. My role as Scientific Editor of *Update* will be to help Mr. Hart decide which scientific materials to include in the publication and to help with the writing and editing of content.

This edition focuses on the recent Conference on Radiation and Health (CRH) held in October 2016. CRH is a major international conference, and RERF was well represented, with a total of 18 scientists giving either oral or poster presentations. In addition, scientific articles appear in the Science Articles section, from page 15 to page 17.

Since our last publication in June 2016, Dr. Akira Hashizume was appointed as RERF Executive Director on October 1 (see his greetings on page 7). Dr. Hashizume worked in Hiroshima 20 years ago at the Hiroshima City Social Affairs Bureau and most recently served as a physician in Fukuoka prefecture. The previous Executive Director, Mr. Takanobu Teramoto, served RERF for more than 10 years, and we wish him the very best as he transitions to retirement (see his message of farewell on page 8). In sadder news, we wish to report the death of Dr. Shigenobu Nagataki, RERF's Chairman from 1997 to 2001, who passed away at age 84 in November.

RERF is beginning to prepare for the 44th Sci-



Dr. Eric Grant, Scientific Editor, in his office

entific Advisory Committee (SAC) meeting, which will be held in March 2017. Each year, a different research department is designated for focused review. In the spring of 2016, the Department of Clinical Studies was reviewed, and in 2017 the department will respond to the recommendations made at that time. The Department of Epidemiology will undergo focused review in 2017, and for this purpose, the SAC has been strengthened by the addition of one Japanese epidemiologist (Dr. Kazuo Tajima, Mie University Graduate School of Medicine) and one U.S.-based epidemiologist (Dr. Amy Berrington de González, U.S. National Cancer Institute). Besides such departmental reviews, the

SAC will also review RERF's three new Research Clusters (Cancer, Non-Cancer, and Genetics), each of which will present its progress over the past 12 months for the first time in special sessions.

I hope that you enjoy this edition. I believe that the new arrangement of the *Update* editorial staff is a positive change and acknowledges the long hours that the Public Relations and Publications Office dedicates to bringing you this publication. We look forward to your feedback.

Eric J. Grant  
Scientific Editor

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*RERF conducts research and studies—for peaceful purposes—on medical effects of radiation and associated diseases in humans, with a view to contributing to maintenance of the health and welfare of the atomic-bomb survivors and to enhancement of the health of all humankind.*

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**Scientific Editor:** Eric J. Grant, Associate Chief of Research

**Technical Editors:** Jun Kitamura, Sayaka Green, Yutaka Ogasawara, Public Relations and Publications Office

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*Contributions to RERF Update receive editorial review only and do not receive scientific peer review. The opinions expressed herein are those of the authors only and do not necessarily reflect RERF policies or positions.*

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