Betalight™

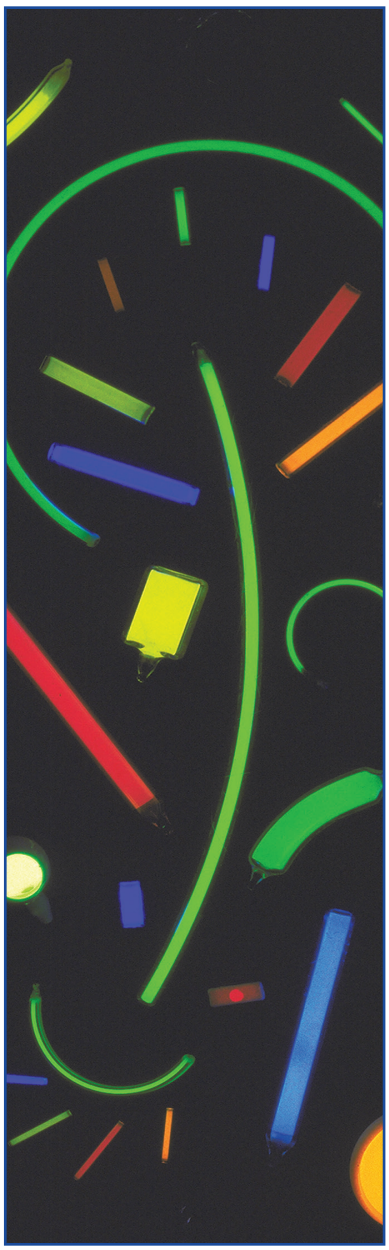
WWW.SRBT.COM

SRBT ISO 9001

March 29, 2019 - ISSUE 22

Company Background

- SRB has been in operation since 1990 and is located at 320 Boundary Road in Pembroke.
- Our company employs approximately 42 hard working local residents.
- SRB is a locally owned and operated Class 1B Nuclear Substance Processing Facility regulated by the Canadian Nuclear Safety Commission (CNSC).
- We are totally committed to protecting the local environment, our employees, the public and to meeting the safety requirements of the CNSC.

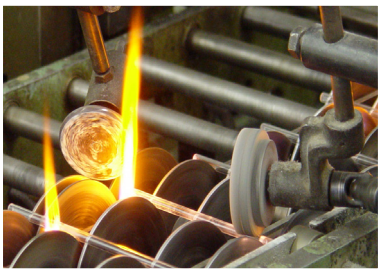


What is a Betalight™?

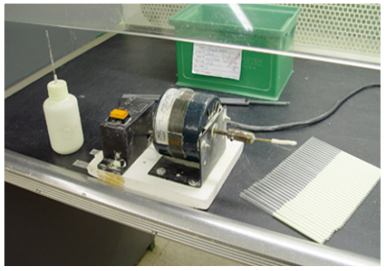
- All products manufactured and designed by SRB use Betalights™.
- A Betalight™ is a sealed glass capsule internally coated with a phosphoresecent powder and filled with a radioactive gas called tritium to produce continuous light.
- First developed in the 1960's, Betalights™ were initially deployed within the defense and transportation industries (ie: backlighting of instrument panels and switch lighting).
- They can be manufactured in a variety of shapes, sizes and colours.
- By using varying amounts of tritium, the brightness of the Betalight™ can be controlled as well as the life time for the Betalight™ to produce a desired or required brightness.

How does a Betalight™ Generate Light?

- When tritium decays, an electron is emitted from the nucleus.
- The electron is a source of energy that interacts to energize a phosphorescent powder which produces light.
- This is achieved by positioning the phosphorescent powder in close proximity to the gas, enabling the electrons to interact with the powder, causing it to emit photons. These photons of light energy are like those in a TV picture tube or a computer monitor, but instead use the energy of the electrons emitted from the tritium rather than from electricity.
- These electrons, or beta particles, emitted by the decay of tritium can only travel short distances in air (about 4.5 mm). The electrons do not have sufficient energy to penetrate even a single sheet of paper. It is therefore essential that the gas is in close proximity with the phosphorescent powder so that the electrons can interact. This is achieved by placing the powder on the inside surface of the glass capsule where it can be readily energized.



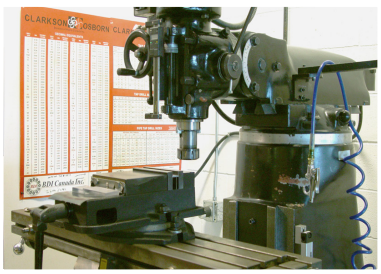
Glassblowing



Coating

Tritium Processing

Assembly



Machining

Why Choose Betalights™?

- Betalights™ are absolutely reliable.
- Betalights™ do not require batteries, filament or incandescent bulbs or switches.
- Betalights™ do not require ambient light for charging.
- Betalights™ are a continuous light source.
- Betalights™ are compatible with night-vision equipment.
- Betalights™ do not disrupt a soldier's acquired night vision.
- Betalights™ are extremely lightweight and compact.
- Betalights™ are highly suitable for portable equipment.
- Betalights™ are maintenance-free during a long service life of up to 20 years.
- Betalights™ will continue to operate normally in temperatures ranging from -70˚C. to 100˚C and in high humidity, even when immersed in water.
- Betalights™ do not produce electrical noise and are safe for use in hazardous areas.
- Betalights™ make useful contibutions to energy conservation.

Description of Manufacturing Processes

- All products manufactured and designed by SRB use Betalights™.
- A Betalight™ is a sealed glass capsule internally coated with a phosphorescent powder and filled with a radioactive gas called tritium to produce continuous light.
- Our products are manufactured to strict procedures and audited on a regular basis by a number of independent third parties from government and industry.
- Our company is ISO 9001 registered, ensuring all processes are performed in a controlled and repeatable manner.
- Any radioactive waste genenerated from the facility is disposed of to a CNSC licensed waste facility or by other means with the approval of the CNSC.
- During the manufacturing process small quantities of tritium are released into the environment through our two exhaust stacks.
- Tritium is our single largest cost and precautions are taken during manufacturing to ensure emissions to the environment are minimized.
- Emissions have dropped significantly. Tritium released per week has dropped significantly from 23,546 GBq/week in 2005 to 638 GBq/week in 2018, a decrease of just over 97%.

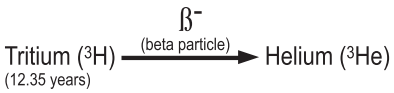
Outline of Company Products

- Our products are used in safety and emergency applications all over the world.
- Without electricity, batteries or any other source of power, our products will help to reduce energy consumption which helps the environment against global warming.
- SRB also manufactures many illuminated products used by Canadian, British, American and other peacekeeping troops.
- We also supply a variety of light sources for use in compasses, gauges, dials and other lighting applications.
- The energy emitted from tritium does not penetrate Betalights™ , so there is no external radiation hazard from our products.
- The Betalights™ within each device and the devices themselves are thoroughly tested to minimize the possibility of breakage.
- In the unlikely event that an exit sign containing 20 curies of tritium is broken, the dose to an individual is expected to be less than the annual public dose limit set by the CNSC of 1.0 millisieverts (mSv) and would depend on the amount of tritium left in the device and the size and ventilation in the room where the device is broken.

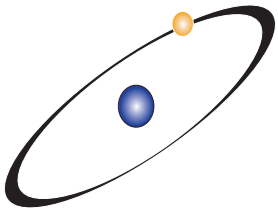
Beta Radiation

- Beta Radiation is an electron emitted by an unstable nucleus. It does not normally penetrate beyond the top layer of skin.[6]

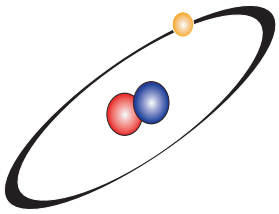
Tritium



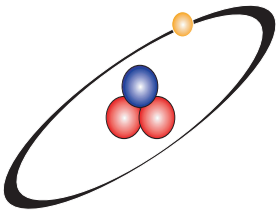
- Tritium is a colorless and odorless radioactive isotope of hydrogen.[1]
- People are exposed to small amounts of tritium every day, since it is widely dispersed in the environment and in the food chain.[1]
- Tritium is produced naturally in the upper atmosphere. Tritium is also produced during nuclear weapons explosions and as a byproduct in reactors. Tritium is also used in studies investigating the safety of potential new drugs.[1]
- Tritium enters the body when people swallow tritiated water, and may also enter the body when people inhale tritium as a gas in the air, and absorb it through their skin.[1]
- Once tritium enters the body, it disperses quickly and is uniformly distributed throughout the body. Tritium is excreted through the urine within a month or so after ingestion.[1]



Hydrogen ^{1}H
1 electron
1 proton



Deuterium ^{2}H or D
1 electron
1 proton
1 neutron



Tritium ^{3}H or T
1 electron
1 proton
2 neutrons

Effects on the Environment and the Public

- Based on monitoring results, at maximum, the dose to a child or adult from SRB would be just under 0.004 mSv/year, much less than 1% of the public dose limit of 1.0 mSv/year. This assumes this child or adult resides very close to SRB, breathing air due to the emissions from SRB, drinking well water or formula mixed with well water and assuming this individual ate 100% of their diet from local gardens.
- Since SRB has been in operation, radiation doses to the public have been well below the public dose limit of 1.0 mSv/year, and have not caused an unreasonable risk to the health of the public.
- Below 50 to 100 mSv, which includes occupational and environmental exposures, risks of health effects are either too small to be observed or are nonexistent.[2]
- The International Commission of Radiological Protection (ICRP) have however attempted to determine the probability of fatal and non-fatal cancers, and hereditary effects from any dose of radiation. The probability in total is 0.000073 per mSv.[3] Therefore, less than one out of approximately 3.5 million people could possibly develop these effects if every individual received a dose of 0.004 mSv.
- SRB continued to contribute to the decommissioning fund in 2018. The decommissioning fund is now fully funded at 100%.

Effects	Detriment (per mSv)
Fatal cancer	0.000050
Non fatal cancer	0.000010
Severe hereditary effects	0.000013
Total	0.000073

[3]

Groundwater

- SRB's groundwater study includes regular monitoring data from 57 wells drilled to various depths, 36 wells are located within approximately 150 meters of our facility.
- The contamination of groundwater is at a level that does not pose a risk to any member of the public. The groundwater on the land where SRB is located is not being used as a source of drinking water.
- The planned decrease in emissions together with natural decay will eliminate tritium concentrations in groundwater in excess of the drinking water guideline over time.
- Tritium concentrations in wells used for drinking water ranges from <4 Bq/L to approximately 1,047 Bq/L, which is just less than 15% of the Ontario Drinking Water Guideline of 7,000 Bq/L.

Monitoring

WHAT IS MONITORED CURRENTLY	FREQUENCY
Facility stack emissions	Weekly
40 air monitoring stations	Monthly
29 monitoring wells	Monthly
8 residential and business wells	Every 4 Months
5 CN monitoring wells	Every 4 Months
Muskrat River	Random
Locally grown produce	Yearly
Local milk	Every 4 Months
8 precipitation monitors	Monthly
6 facility downspouts	Random
Sludge Samples	Twice Yearly

Note: All results are communicated to the CNSC and available on our web site.

Public Dose in Perspective

mSv		
100.00	H	994 out of 1000 individuals exposed to 100 mSv would not develop cancer.[4] Risk of disease or death is increased by 10% among those who receive 100 mSv.[5] **(H on Graph)**
7.00	G	Brain Scan.[6] **(G on Graph)**
2.40	F	On average, public radiation exposure in Canada due to all natural sources.[6] **(F on Graph)**
1.00	E	CNSC annual public dose limit. **(E on Graph)**
0.50	D	Abdomen x-ray.[6] **(D on Graph)**
0.48	C	The highest dose to an SRB employee (in 2018). **(C on Graph)**
0.044	B	The average dose to SRB employees (in 2018). **(B on Graph)**
0.004	A	Maximum annual dose to the public due to SRB (in 2018). **(A on Graph)**

Natural Radiation

Cosmic Radiation

- Cosmic rays are mainly protons of uncertain origin in space and very high energies that reach our atmosphere in fairly constant numbers. The annual effective dose from cosmic rays at ground level is about 0.4 mSv, on average. Most people live at low altitudes, and so experience similar annual doses from cosmic radiation. However, in some areas at considerable altitude for example, Denver in the Rocky Mountains, residents may receive annual doses several times higher than those people living at sea level.[6]

Gamma Radiation

- All materials in the Earth's crust contain radionuclides. Energy from natural activity deep in the Earth contributes to the shaping of the crust and the maintenance of internal temperatures. This energy comes mainly from the decay of the radioactive isotopes of uranium, thorium, and potassium. The average effective dose from natural gamma rays is about 0.5 mSv in a year. Actual values vary appreciably and some people may receive doses a few times higher or lower.[6]

Radon inhalation

- Radon gas is a particularly significant source of exposure to natural radiation. If buildings are well ventilated this accumulation of radon will not be marked. However, in many generally colder countries, buildings are constructed with more emphasis on retaining heat and preventing draughts. They are, therefore, often poorly ventilated, and radon concentrations indoors can be many times higher than those outdoors. Radon concentrations in buildings are also very dependent on the local geology and can vary a great deal between different parts of a country and even from building to building in the same area. The worldwide average annual effective dose from the decay products of radon is estimated to be about 1.2 mSv. In some countries the national average is several times higher.[6]

Internal irradiation

- Other radionuclides from the uranium and thorium series, in particular lead-210 and polonium-210, are present in air, food and water and therefore irradiate the body internally. Potassium-40 also comes into the body with the normal diet. The average effective dose from these sources of internal radiation is estimated to be 0.3 mSv in a year.[6]

Total Dosage Due to Natural Radiation

- The total average effective does from natural radiation is about 2.4 mSv in a year, but doses can vary a great deal.[6]

Source	Worldwide average dose (mSv)	Typical range dose (mSv)
Cosmic radiation	0.4	0.3 to 1.0
Gamma radiation	0.5	0.3 to 0.6
Radon inhalation	1.2	0.2 to 10
Internal irradiation	0.3	0.2 to 0.8
Total (rounded)	2.4	1.0 to 10

Other Than Natural Radiation

Diagnostic radiation

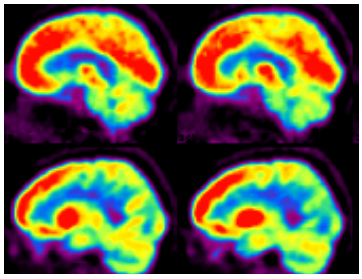
• In a conventional X ray examination, radiation from a machine passes through the patient.[6]

Examination	Conventional x-ray Dose (mSv)
Head	0.07
Teeth	less than 0.1
Chest	0.1
Abdomen	0.5
Pelvis	0.8
Lower spine	2
Lower bowel	6
Limbs and joints	0.06

Nuclear medicine

• For a diagnostic procedure in nuclear medicine, the patient is given a radionuclide in a carrying substance, such as a pharmaceutical, which is preferentially taken up by the tissue or organ under study. Administration may be by injection, ingestion, or inhalation. The radionuclide emits gamma rays.[6]

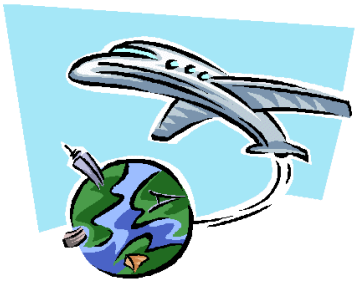
Organ scan	Effective Dose (mSv)
Brain	7.0
Bone	4.0
Thyroid, lung	1.0
Liver, kidney	1.0



Air travel

• Exposure to passengers and crew due to cosmic radiation.[6]

Cities	Effective Dose (mSv)
Vancouver to Honolulu	0.0142
Montreal to London	0.0478
Helsinki to New York	0.0497
London to Tokyo	0.0670
Paris to San Francisco	0.0849



Reference Documentation

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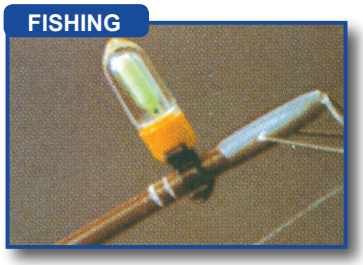
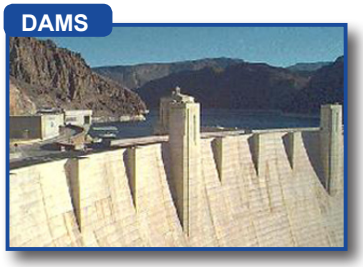
2. HEALTH PHYSICS SOCIETY, Radiation Risk In Perspective, Richard J. Burke Jr., Executive Secretary Health Physics Society, http://hps.org
3. ICRP PUBLICATION 60, 1990 Recommendations of the International Commission of Radiological Protection,PERGAMON PRESS
4. HEALTH PHYSICS SOCIETY, Answer to Question #4703 Submitted to "Ask the Experts", http://hps.org
5. Risk of cancer after low doses of ionising radiation - British Medical Journal, June 29, 2005, https://www.bmj.com
6. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation, People and the Environment, https://www.iaea.org

FISHING



THEATRES

DAMS



STAIRWAYS

HELICOPTERS

TUNNELS

TANKS

MINE CLEARING

TROOPS

MILITARY AIRCRAFT

MARKERS

MILITARY VEHICLES

Contact Information

For more information or if you are interested in participating in a plant tour, please contact:

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For further infomation please visit *http://www.srbt.com* or follow our *Facebook, Instagram* or *Twitter* accounts.

bsi.

By Royal Charter

Certificate of Registration

QUALITY MANAGEMENT SYSTEM - ISO 9001:2015

This is to certify that:

SRB Technologies (Canada) Inc.
320-140 Boundary Road
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Ontario
K8A 6W5
Canada

Holds Certificate No: **FM 64093**

and operates a Quality Management System which complies with the requirements of ISO 9001:2015 for the following scope:

Design and manufacture of tritium filled light sources (Betalights), self powered luminous signs, markers and emergency lighting for military, commercial, aerospace and scientific applications.

For and on behalf of BSI:

Carlos Pitanga, Chief Operating Officer Assurance – Americas

Original Registration Date: 1997-09-19
Latest Revision Date: 2018-12-17

Effective Date: 2018-01-07
Expiry Date: 2022-01-06

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...making excellence a habit.

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