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SAFETY REGULATION

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ROCKET EXPERIMENTATION BY AMATEURS

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STATE OF NEW JERSEY
DEPARTMENT OF LABOR & INDUSTRY
BUREAU OF ENGINEERING & SAFETY
Trenton, N. J.

REGULATION SHELE

REGULATION SHELE

Division of Labor

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FOREWORD

To assist and advise the Department in the preparation of this Regulation, Commissioner Raymond F. Male established the Rocketry Advisory Committee. The membership of that committee is indicated on the preceding page.

In the writing of this Regulation the Department and the Committee were guided by the recommendations of the National Association of Rocketry, Department of the Army, Federal Aviation Agency and Regulations of several states.

This Regulation is promulgated by the Commissioner of Labor and Industry of the State of New Jersey to establish reasonable minimum safety requirements for rocket experimentation by amateurs. It is promulgated under authority vested in the Commissioner by law:

N.J.S.A. 21:1A-131-The Commissioner may make and promulgate rules and regulations necessary to further the purposes of this act. The rules and regulations may include requirements that are not specifically mentioned in this act, but which are reasonably necessary for the safety of workers and the public and the protection of property.

The term "Explosives" as used in this Regulation, is defined in the law itself, as follows:

"Explosives" means any chemical compound or mixture that is commonly used or intended for the purpose of producing an explosion, that contains any oxidizing and combustible materials or other ingredients, in such proportions, quantities or packing that an ignition by fire, by friction, by concussion or by detonation of any part of the compound or mixture may cause such a sudden generation of highly heated gases that the resultant gaseous pressures are capable of producing destruction effects on contiguous objects. The term "explosives" shall include,

but is not limited to commercial explosives, propellants and nitro-carbo-nitrates. The term "explosives" except as specifically stated in this act, shall not include small arms ammunition, explosives in the forms prescribed by the official United States Pharmacopeia, or fireworks regulated under Revised Statutes sections 21:2-1 through 21:2-7.

Prior to its promulgation a draft copy of this Regulation was forwarded to all holders of explosives permits, inviting their review and comments.

SECTION 1 – PURPOSE AND SCOPE

- 1.1 **PURPOSE.** This Regulation is promulgated to establish minimum **safety** requirements and standards for the manufacture and use of explosives in model and amateur rocketry.
- 1.2 **SCOPE.** This Regulation is applicable to rocket experimentation by amateurs, including the mixing of rocket propellants, and the sale, storage, transportation and use of rocket propellants and pre-loaded, factory-made commercial model rocket engines that do not require mixing the propellant.
- 1.3 **EXCEPTIONS.** In cases of practical difficulty or unnecessary hardship, the Commissioner may grant exceptions from the requirements of this Regulation, provided that a request for such exemption has been made in writing. Exceptions can only be granted when it is clearly evident that a satisfactory and safe condition is attained, but cannot be granted in any case where conflict would be created with mandatory requirements of the law.

SECTION 2 – DEFINITIONS

2.1 *General Definitions*

- 2.1.1 *Approved* – approved by the Commissioner.
- 2.1.2 *Commissioner* – The Commissioner of Labor and Industry, or his authorized representative.
- 2.1.3 *Department* – The Department of Labor and Industry.

2.2 *Special Definitions*

- 2.2.1 *Amateur Rocketry* – any of the following activities when performed by an amateur: the compounding and loading of propellants; the fabrication of rocket engines; or the design, construction and use of rockets containing substantial metal parts.

2.2.2 *Model Rocketry* – the design, construction and use of model rockets containing no substantial metal parts, and which use a solid propellant rocket engine produced by a commercial manufacturer.

2.2.3 *Model Rocket* – an aero model that is propelled by means of a model rocket engine, includes a recovery device for returning it safely to the ground, and which is made of paper, wood, or breakable plastic and contains no substantial metal parts. The rocket shall not exceed 16 ounces in weight nor have more than three stages.

2.2.4 *Model Rocket Engine* – a solid propellant rocket engine or rocket propellant produced by a commercial manufacturer in which all chemical ingredients of a combustible nature are pre-mixed and ready for use.

2.2.5 *Amateur Rocket* – a rocket vehicle that is propelled by means of a propellant engine produced by other than a commercial manufacturer, or weighs more than 16 ounces, or is not made of paper, wood, or breakable plastic.

2.2.6 *Amateur Rocket Engine* – a solid or liquid propellant rocket engine in which any chemical ingredients of a combustible nature have been mixed by other than a commercial manufacturer.

SECTION 3 – GENERAL PROVISIONS

3.1 *Compliance* - All manufacture, sale, storage, transportation and use of propellants, oxidizers and rocket engines, and the launching of any type of rocket shall comply with the requirements of this Regulation.

3.2 *Age Limitations* – Persons less than 15 years of age are not permitted to participate in the preparation or use of propellants. Persons 15 years of age or older are permitted to assist in the preparation or use of propellants when such activity is performed under the control and supervision of a person in possession of a valid permit issued hereunder and all such persons must comply with these rules and regulations.

3.3 *Excluded Explosives* - Excluded Explosives, as listed in Section 8.1 of Safety Regulation No. 20 shall not be used.

3.4 *Rocket Design and Construction*

3.4.1 Rockets shall be designed and constructed in compliance with accepted aerodynamic principles.

3.4.2 Rockets shall be designed and constructed in such a manner as to have attached surfaces which will provide the necessary aerodynamic stabilizing and restoring forces to maintain a true and predictable flight.

3.5 *Rocket Engine Igniters* - No igniter containing pyrotechnic material shall be inserted in the rocket engine until the rocket is ready for thrust stand tests, or launching.

3.6 *Rocket Launching*

3.6.1 All rockets shall be launched from launching devices or mechanisms which shall contain the yaw and pitch axes of the models until sufficient flight velocity is achieved for the stabilizing surfaces to exert adequate aerodynamic stabilizing forces.

3.6.2 No rocket shall be launched at an angle less than 60° from the horizontal.

3.6.3 No rocket shall be fired as a weapon against targets in the air or on the ground.

3.6.4 No rocket shall contain any explosive warheads.

3.7 *Rocket Ignition*

3.7.1 Rockets shall be launched by electrical means only, and fully under the control of the permit holder.

3.7.2 Electrical firing systems shall contain safety circuits or devices to insure that launching or ignition does not occur unless planned steps are taken in sequence, in accordance with a written "standard operating procedure".

- 3.7.3 Electrical firing circuits or devices shall be checked for proper operation and "no voltage" before launchings take place.
- 3.7.4 Ignition or launching of model rockets shall take place only in the presence and under the supervision of person holding a permit.
- 3.7.5 No rocket shall be ignited or launched unless all persons in the vicinity of the launching area are at a safe distance and are aware that ignition and launching are imminent.
- 3.7.6 The firing circuit shall not be armed until the permit holder has made a careful visual check of the surrounding area and has made a sky sweep to insure the absence of aircraft which might enter the flight path of the rocket.
- 3.7.7 A minimum five second count-down shall be given before the ignition or launching of any rocket.
- 3.7.8 In the event of a misfire, igniter failure, or other abort, the permit holder shall return the firing system to a safe condition. No one shall approach the model until its condition has been pronounced safe by the permit holder.

3.8 *Rocket Flights - Weather Factors*

- 3.8.1 Rockets shall not be flown during weather conditions that might adversely affect the flight path or the flight characteristics of the rocket, such as
 - a. high winds
 - b. gusty winds
 - c. other inclement conditions
- 3.8.2 Rockets shall not be flown when the visibility is less than one mile.
- 3.8.3 Rockets shall not be flown into any cloud, nor flown after sunset.

3.9 *Flight Area - Markings*

- 3.9.1 A flight operation area, when in use, shall be plainly marked as being the site of rocket operations by ~~the flying~~ of a red flag at least 12 inches square at a height no less than 7 feet above the ground.
- 3.9.2 Flashing red lights at a height no less than 7 feet above the ground at the range control point may also be used to indicate that an area is in use as a rocket flight operations area.
- 3.9.3 Road and walkway approaches to rocket flight operation area shall be posted with warning signs when the area is in use.

3.10 *Flight Area - Command*

- 3.10.1 During operations in a flight area, the permit holder shall have supreme authority.
- 3.10.2 The permit holder should possess an interlock safety key, or switch guard, or equivalent, which shall prevent the launching of rockets.
- 3.10.3 All rockets presented for operation on the range, shall be admitted or rejected by the permit holder on the basis of his judgment alone.

3.11 *Flight Area - Personnel Control*

- 3.11.1 All personnel in the flight operations area shall be under the control of the permit holder.
- 3.11.2 The number of persons in the launch area shall be the minimum, as determined by the permit holder.
- 3.11.3 Spectators shall be required to remain within the bounds of a specified spectator's area, which shall be located in such a position as to insure maximum safety.

- 3.12 *Municipal Approval* - A flight area should not be used until the permit holder has contacted municipal authorities regarding any restrictions.

SECTION 4 - PERMITS

4.1 *Permit Restrictions*

- 4.1.1 No person shall use any model rocket engine, propellant or other explosive unless a permit shall have been issued, as herein provided.
- 4.1.2 It is prohibited for any person to sell any rocket engine, propellant or other explosives to any person not in possession of a valid permit to use explosives.
- 4.1.3 No permit can be assigned or in any way transferred.
- 4.1.4 No person shall manufacture, sell, transport, store or use any rocket engine, propellant or other explosives except in compliance with the limitations expressed on the permit.

4.2 *Permit Application*

- 4.2.1 Applications for a permit shall be made to the Commissioner on forms provided by him and shall contain such information as the Commissioner may require.
- 4.2.2 Any permit is revocable for cause, by the Commissioner.
- 4.2.3 An applicant for a permit to use model rocket engines must have knowledge of the principles of safe model rocketry, as contained in this Regulation, and must be at least 21 years of age.
- 4.2.4 An applicant for a permit to prepare and use propellants in amateur rocketry must demonstrate his knowledge of, and qualifications in the safe preparation and use of propellants, and must be at least 21 years of age.

4.3 *Permit Classes*

- 4.3.1 Two types of permits will be issued to cover the activities associated with rocket experimentation by amateurs. The class of each permit, the activity each authorizes and the annual fee are as follows:

a. *To sell* - authorizes the sale
of model rocket engines . . . \$10.00

b. *To use* -

(1) Model Rocketry - authorizing
the purchase and use of model
rocket engines 1.00

(2) Amateur Rocketry - author-
izing the preparation and
use of propellants 1.00

SECTION 5 - MODEL ROCKETRY

5.1 *Design and Construction*

5.1.1 Model rockets shall contain a means for retard-
ing their descent to the ground in such a way
that there is no danger to persons or property.

5.1.2 Model rockets shall be constructed of wood,
plastic, rubber, paper, or similar materials and
shall contain no substantial metal parts.

5.2 *Limiting Model Factors* - No model rocket shall ex-
ceed a gross or launching weight of sixteen (16)
ounces, or shall be composed of more than three
stages.

5.3 *Model Rocket Engines - Minimum Standards*

5.3.1 A model rocket engine shall be so designed
that the rocket engine casing shall not rupture
under normal operating conditions.

5.3.2 If a model rocket engine is not made of paper,
wood or breakable plastic, a sufficient blowout
disc or other safety release shall be provided
as an integral part of the engine to prevent
rupture of the engine casing in the event of
internal overpressure.

5.3.3 A model rocket engine shall not be capable of
spontaneous ignition or combustion in air, in
water, under pneumatic or hydraulic pressure, or
as a result of motion or jarring, or when sub-
jected to a heat of 170° F. or more, or in glyc-
erine.

5.4 *Model Rocket Engines - Testing and Certification*

- 5.4.1 All model rocket engines available for sale shall be approved by the Commissioner of Labor and Industry.
- 5.4.2 Approval of model rocket engines shall be guided by the standards and recommendations of the National Association of Rocketry, and recognized rocket authorities and agencies.

5.5 *Model Rocket Engines - Use*

- 5.5.1 Model rocket engines shall not be altered in any manner to change their performance characteristics or dimensions, but non-metallic casings may be trimmed slightly around their forward end in order to fit properly into engine mountings.
- 5.5.2 Model rocket engines shall not be used for any purpose except on model rockets which are specifically designed to perform properly with the type of engine being used.
- 5.5.3 No model rocket engine casing shall be re-loaded unless so designed by the manufacturer, and then only with commercially produced propellant.

- 5.6 *Rocket Flights - Obstacles* - No rocket flight shall be adjacent to high-voltage power lines, major highways, multi-story buildings, or other obstacles which would constitute hazards to the flight of model rockets, or which might be endangered by the flight of model rockets.

5.7 *Flight Area - Size*

- 5.7.1 The dimensions of the area to be utilized for flight operations of model rocket engines shall conform with the following:
 - a. For any expected altitude up to 750 feet, the area utilized shall contain at least 5,000 square yards, be generally rectangular in form and have no side less than 50 yards long.
 - b. For any expected altitude above 750 feet, the area utilized shall be generally rec-

tangular in form and the length of any side shall not be less than the expected altitude of the rocket.

- 5.7.2 For other than vertical flight operations of model rocket engines, the area to be utilized shall be of sufficient size to keep the rocket within the flight area until the deployment of the recovery system.

5.8 *Flight Area - Location*

- 5.8.1 Flight operation areas shall be located in such a place as not to endanger the life or property of individuals in the vicinity of the area.
- 5.8.2 No flight operations shall be located within 5 miles of a major airfield nor within 2 miles of any airfield, unless prior written permission is obtained from the airport officials.

SECTION 6 - AMATEUR ROCKETRY

- 6.1 *Exceptions* - Nothing in this section shall be construed as applying to any phase of amateur rocketry within areas under the jurisdiction of the Military Forces of the United States.

6.2 *Restrictions*

- 6.2.1 No liquid propellants shall be used unless a special permit has been obtained under Section 4.3.1 (b).
- 6.2.2 No chlorates, picrates, iodates or fulminates shall be used for rocket experimentation.
- 6.2.3 The requirements under Section 6.4 are applicable only for mixtures of zinc and sulphur; mixing of any other solid propellants shall comply with the requirements of Section 6.5. The handling and use of liquid propellants shall comply with the requirements of Section 6.6.

6.3 *Compounding of Propellants -;Quantities*

- 6.3.1 A quantity of propellant having a weight of 4 ounces or less shall be classified as a laboratory sample.

- 6.3.2 A quantity of propellant having a weight of more than 4 ounces shall be classified as a production unit.

6.4 *Compounding of Propellants - Laboratory Samples*

- 6.4.1 All mixing and laboratory work shall be accomplished in the open air, or in a well ventilated room.
- 6.4.2 All equipment used in the mixing of propellants, or the handling of the propellants shall be grounded.
- 6.4.3 Only the minimum number of essential people shall be near propellant mixing operations.
- 6.4.4 When mixing chemicals the following protective equipment shall be used.
- a. Heavy rubber apron
 - b. Face shield
 - c. Protective glasses
 - d. Gloves and arm coverings
- 6.4.5 All utensils used in mixing ingredients shall be made of non-metallic or non-sparking materials.
- 6.4.6 No mixture shall be heated unless the heating is accomplished in accordance with the provisions of Section 6.5.7.
- 6.4.7 No mixture shall be ground or subjected to compression or shock.
- 6.4.8 The quantity of propellant to be mixed shall not exceed that which is necessary to load one rocket engine at a time.
- 6.4.9 Fire fighting equipment shall be available and be capable of fighting fire within the confines of the mixing area.
- 6.4.10 First aid supplies shall be available in the mixing area.

6.5 *Compounding of Propellants - Production Units*

- 6.5.1 The mixing of more than 4 ounces of zinc and sulphur, or the mixing of any quantity of other propellant ingredients shall only be accomplished in accordance with the provisions of this Section.
- 6.5.2 All mixing and laboratory work shall be accomplished in a building specifically constructed for that purpose or in the open air with protective barricades provided.
- 6.5.3 All mixing, other than the mixing of zinc and sulphur, shall be done remotely.
- 6.5.4 Every building used for the mixing of propellants shall be equipped with the following:
 - a. Fire fighting equipment consisting of extinguishers or automatic sprinkler system.
 - b. Lights, switches and motors, if used, shall be explosion proof.
 - c. First aid kit.
 - d. A heavy blanket, preferably asbestos or impregnated canvas.
- 6.5.5 All equipment used in the mixing or handling of propellants shall be grounded, and made of non-sparking material.
- 6.5.6 The quantity of propellant to be mixed shall not exceed that which is necessary to load one rocket at a time.
- 6.5.7 No mixture shall be heated or cooked unless the following additional precautions are taken.
 - a. A means is provided for measuring the temperature of the mixture to within plus or minus one degree Centigrade.
 - b. A safety margin of at least 100 degrees C. is held between the mixing temperature and the flash temperature of the mixture.

- c. All persons present are behind protective barricades and the mixing is remotely controlled.

6.6 *Liquid Propellants*

- 6.6.1 The transportation and storage of liquid propellants shall comply with Sections 7.1 and 7.2 of this Regulation, and in addition shall be accomplished in containers made of a material which will not react with or otherwise be corroded by the liquid propellant, nor permit the escape of toxic or flammable fumes. Also, the oxidizer and fuel of bi-propellants shall not be transported in the same vehicle nor stored in the same building.
- 6.6.2 Tanks, feed lines, pumps, injectors, and all other components of the rocket which come in contact with the liquid propellant shall be made of a material which will not be corroded by the propellant.
- 6.6.3 Rockets shall be designed and constructed in accordance with any special requirements of the particular propellants being used.
- 6.6.4 Transfer and loading of propellants shall be accomplished only in the open air, only in special areas provided for this purpose, and only by persons wearing the following protective equipment.
 - a. Fireproof apron
 - b. Face mask
 - c. Gloves capable of protecting against corrosive and toxic effects of the propellant.
- 6.6.5 No persons not essential to the loading operation shall be within 100 feet of the propellant loading area when propellants are being loaded, unless they are behind protective barricades.
- 6.6.6 Whenever possible, liquid propellants shall not be loaded into a rocket until it is placed on the launcher or test stand.

6.6.7 All safety precautions normally applicable to the handling of particular propellants being used shall be followed.

6.6.8 Fire fighting equipment shall be available wherever liquid propellants are stored, transferred, or loaded.

6.7 *Preflight Test Requirements*

6.7.1 No newly designed rocket shall be launched unless the following tests of the rocket system are accomplished.

- a. Rocket engine shall be tested to determine its thrust, its burning time, its heat resistance and conductivity, and be hydrostatically tested to $1\frac{1}{2}$ times the calculated chamber pressure.
- b. Fins shall be tested for aerodynamic behavior and shear strength.
- c. Diaphragms shall be tested to determine their rupture pressure, and to determine whether they will shatter or melt.
- d. Mechanisms - all mechanical devices shall be tested to determine whether they will function under the conditions to which they are to be subjected, and to determine that they are in working order immediately prior to launching.
- e. Igniters shall be pretested for their ability to produce sufficient heat, and examined for breaks and short circuits.
- f. Propellants shall be tested for means of ignition, and burning rate and that the ignition temperature is above 170° F.
- g. Bulkheads shall be tested to determine adequacy of shear strength and heat resistance.
- h. Launching racks shall be tested for stability, whip and accuracy of angle of elevation.

- i. All batteries, switches, electrical circuits and other electronic devices shall be tested initially to insure that they will perform their assigned functions, and then examined carefully prior to actual use to insure that they are in operative condition.

6.7.2 If any part of the rocket system is changed, the appropriate tests in Section 6.6.1 shall be made on the part that has been changed.

6.8 *Static Tests*

6.8.1 Static tests shall only be made on test stands which are securely anchored to the ground and of such construction that they can withstand twice the expected thrust developed by the rocket engine.

6.8.2 The test stand shall be emplaced in the ground, or a barricade built around it to a height above the nozzle exit of the largest rocket to be tested.

6.8.3 Static tests shall be made in an area remote from buildings, highways and railroads.

6.9 *Static Test Bay*

6.9.1 Sufficient barricades shall be constructed around the test stand to prevent any fragments of an explosion of the rocket engine from escaping outside the safe, clear surrounding area; and including sufficient overhead covering to contain any rocket engine which may work loose from the test stand.

6.9.2 The test firing pit shall be well ventilated and have an open side in the direction that the gasses are expelled, and a baffle shall be constructed at a reasonable distance from the open side so as to stop any solid object that might fly in that direction.

6.9.3 Static tests shall be observed and controlled from an observation bunker having a wall facing the test stand equivalent in strength to at least two feet of sand, and provided with an overhead cover of substantial thickness and a means of rapid exit of personnel.

6.9.4 Observations from the bunker shall be made by means of periscopes or through bullet proof glass.

6.9.5 No person not located in the bunker or other protective emplacement shall be within 500 feet of the test stand during a firing.

6.10 *Launching Facility*

6.10.1 No launching facility of any nature shall be used unless the facility has been approved by the Commissioner.

6.10.2 An amateur rocket may not be operated unless at least 24 hours, but not more than 48 hours, prior notice is given to the nearest Federal Aviation Agency air traffic control facility. This notice shall include:

1. Name and address of the person in charge of the operation;
2. The number of rockets to be operated;
3. The maximum altitude to which the rocket will be operated;
4. The geographical location of the operation;
5. Date, time and duration of operation; and
6. Other pertinent information requested by air traffic control.

6.10.3 Every facility shall include the following:

- a. Launching pit
- b. Control bunker
- c. Propellant loading area
- d. Bunker for observers
- e. Shelters for spectators

6.10.4 Fire fighting equipment shall be available and be capable of fighting fire wherever it may occur within the confines of the launching facility.

6.10.5 First aid supplies shall be available and persons shall be present who are trained to use them.

6.10.6 A complete operating procedure and safety rules shall be posted at the launching facility.

6.11 *Rocket Firing Procedures*

6.11.1 Rockets shall be ignited by electrical means only, controlled from the firing bunker.

6.11.2 The firing circuit shall provide a means of preventing firing unless a safety plug or key is properly inserted and this plug or key shall be in the possession of the last person to leave the rocket before firing.

6.11.3 A means shall be provided for checking that all persons present are in safe positions before the rocket is fired.

6.11.4 All persons participating in the firing shall be thoroughly familiar with the posted operating procedure.

6.11.5 In the event of a misfire, i.e., a condition in which the propellant fails to ignite or burns partially so that a rocket engine still containing propellant remains in the launcher or test stand, the following steps shall be taken in sequence.

- a. After a one-minute waiting period during which no one shall leave the protected areas, the firing may be attempted again.
- b. If the rocket still fails to fire, a check of the electrical firing circuit shall be made from within the firing bunker, as far as is possible.
- c. If a defect is found which can be corrected from within the bunker, then it may be corrected and the firing attempted again. If not, then an additional 15-minute waiting period shall begin during which no persons shall leave the protected areas.

- d. After the 15 minute waiting period, if the rocket still has not fired, then one person, wearing a helmet, face shield, heavy apron, and gloves, shall proceed to disarm the rocket, using extreme caution and following specified procedures.

6.11.6 In addition to the above, any additional special precautions which might apply to a particular rocket, shall be taken.

SECTION 7 - TRANSPORTATION AND STORAGE

7.1 *Transportation*

7.1.1 The transportation of any propellant, other than model rocket engines, shall conform with Safety Regulation No. 21 governing the Transportation of Explosives; except that a propellant having a weight of 10 pounds or less shall conform to the requirements governing the transportation of laboratory samples.

7.1.2 Model rocket engines, in quantities of 250 or less shall be classified as Laboratory Samples and packed in well secured metal, glass or plastic containers or cardboard inside packages. No label is required.

7.1.3 No ignition device shall be transported in the same container with a rocket engine.

7.2 *Storage*

7.2.1 Any propellant or model rocket engines having a weight of more than 10 pounds shall be stored in a magazine for which a permit has been issued by the Commissioner.

7.2.2 Any propellant or model rocket engine having a weight of 10 pounds or less shall be stored in a container lined with non-sparking material and the container shall be marked "Explosives" except when special storage is required by the permit, or when an exception is granted by the Commissioner.