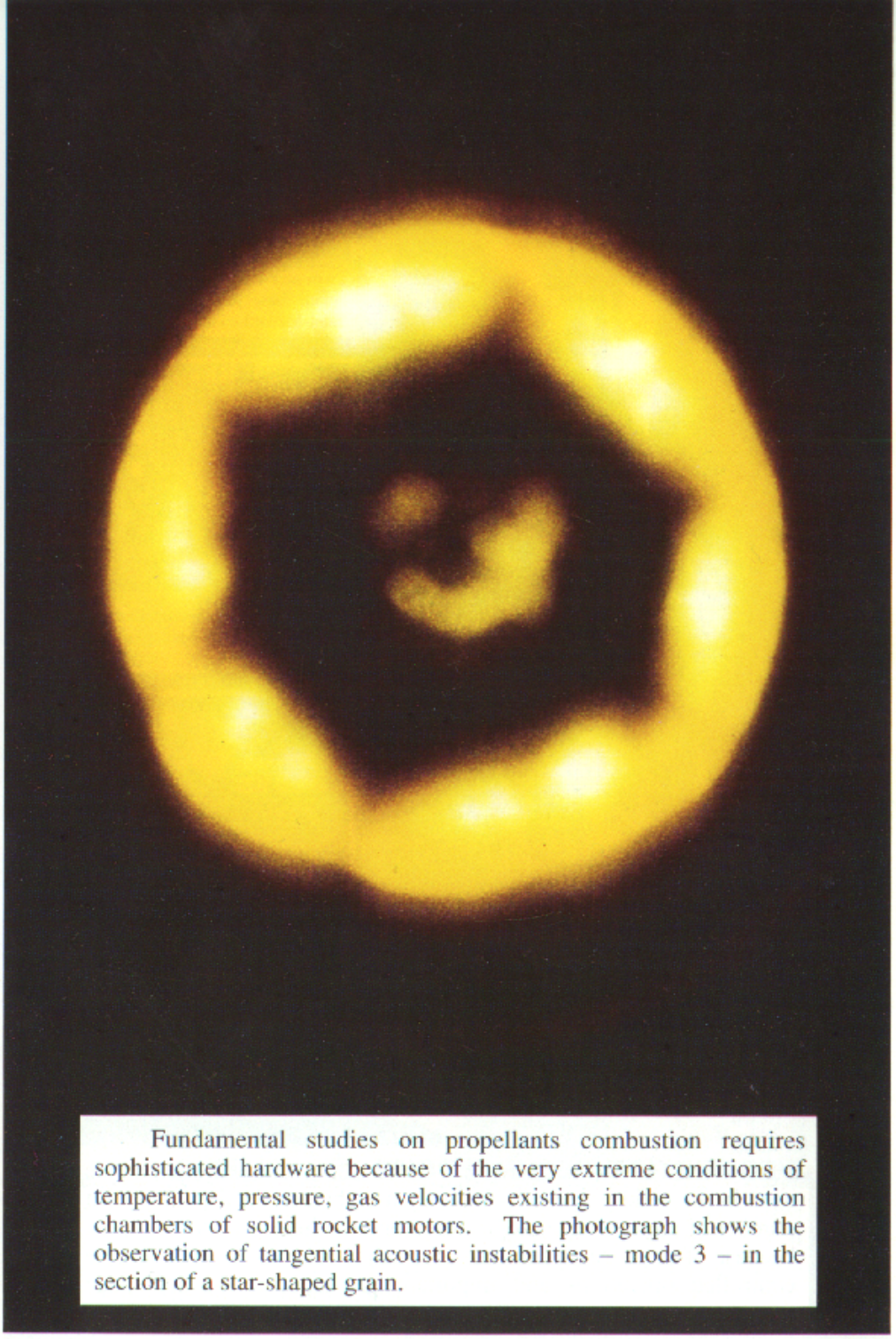
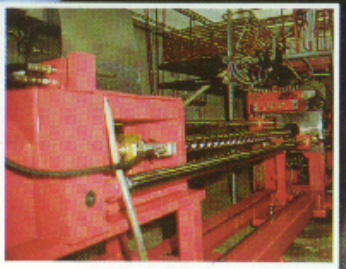
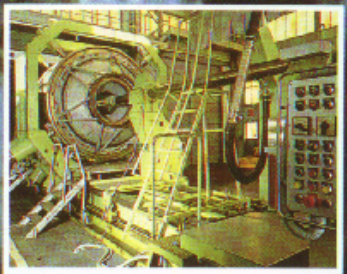


Fundamental studies on propellants combustion requires sophisticated hardware because of the very extreme conditions of temperature, pressure, gas velocities existing in the combustion chambers of solid rocket motors. The photograph shows the observation of tangential acoustic instabilities – mode 3 – in the section of a star-shaped grain.



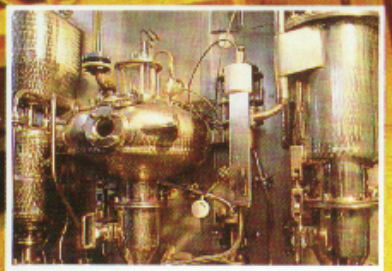
Twin screw continuous extrusion of double base propellants (SNPE – Saint-Médard-en-Jalles plant).



Machining of a big propellant grain (SNPE – Saint-Médard-en-Jalles plant).

Robot for filling a motor case with casting powder for CDB propellant (SNPE – Angoulême plant).

PRODUCTION TECHNOLOGIES The industrial equipments used in the solid propellants industry are characterized by the great number of various technologies used and the high investment costs, because of the necessity to have, for safety reasons, a lot of remote controlled operations and important protections. The left page



Nitric esters production plant (SNPE – Angoulême).

UDMH (unsymmetrical dimethyl hydrazine) production plant for Ariane Viking motors (SNPE – Toulouse plant).

illustrates the batch mixing of a solid propellant. The mixer's bowl is lowered and the blades are visible. The right page shows a typical radiographic facility for inspection of big propellant grains (SNPE – Saint-Médard-en-Jalles plant).

Composite propellant case-bonded motor for an air to ground rocket.

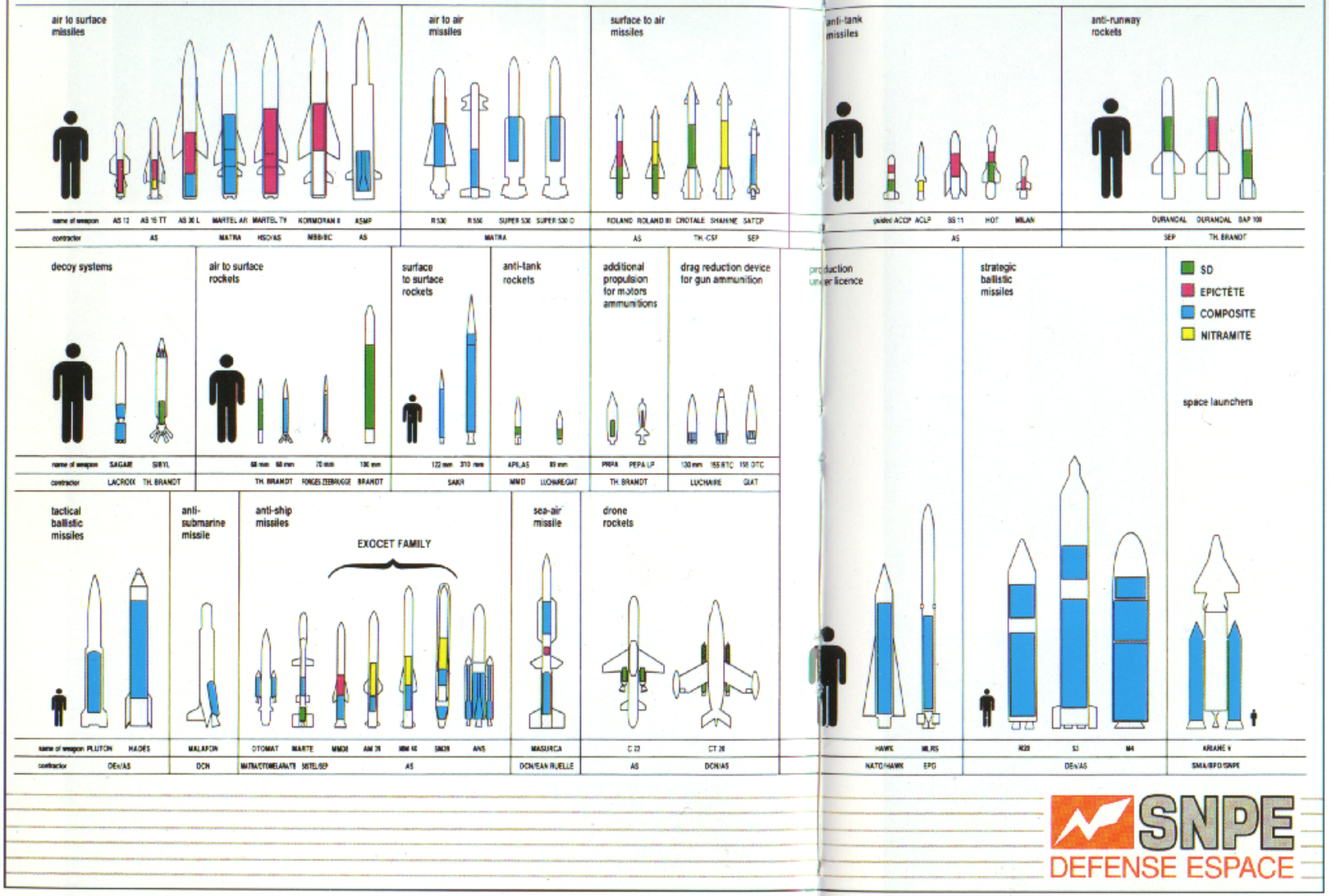
Vibration testing of a new ballistic missile motor.

Computer assisted design of static test hardware.

Wind tunnel testing of a model of a new antiship supersonic missile with integral booster and ramjet sustainer (photo ONERA).

INNOVATION Constant requirements for the improvement of missiles and space boosters performances lead to the necessity of progress on every subsystem, and specifically on propulsion systems. While the very successful EXOCET antiship missile family is still under production, the engineering teams are designing and testing the propulsion unit of the next generation (photo AEROSPATIALE).

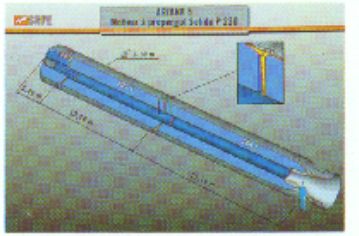
SNPE Production



SNPE
DEFENSE ESPACE

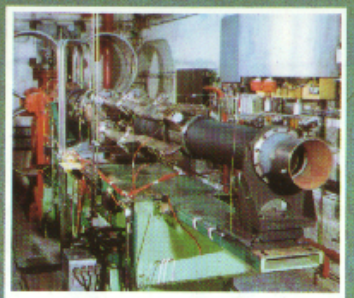
Air to air missile motor.

EDB solid propellant grains.



Internal view of a segmented space launcher booster.

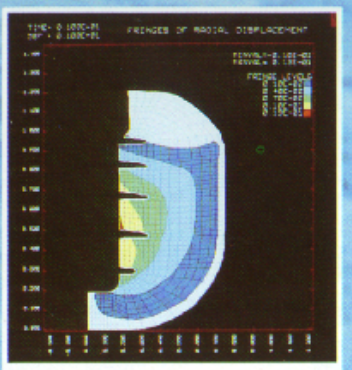
INDUSTRIALIZATION Solid propellant grains are designed according to requirements for various different missions. These designs use a great variety of shapes,. masses, dimensions and propellant formulations. This page illustrates the main propellant grains under development and production at SNPE in 1988. The scale of propellant masses involved goes from a few grams (thrusters) to a few hundred tons (ARIANE 5 solid boosters).



Static test hardware for a solid propellant ramrocket (photo ONERA).

Solid propellant mechanical behaviour testing at extreme temperatures.

SOPHISTICATION The methodologies, équipment, R and D work used in the solid propulsion industry have always used the higher performing technologies of the time... The importance and cost of its applications, the constant requirement for improved performances, justify the use of the most sophisticated equipments. This is particularly illustrated by the Submarine Launched Ballistic Missiles.



Graphic display of the structural analysis of a case-bonded propellant grain.

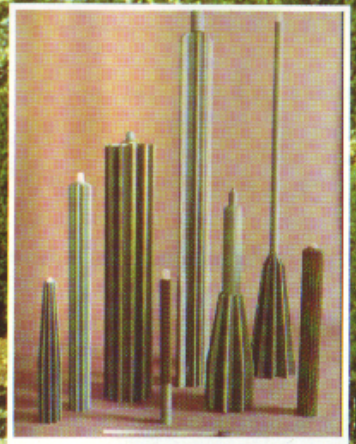
Physico chemical analysis of solid propellants.

Centrifuge for acceleration testing of solid rocket motors (SNPE – Saint-Médard-en-Jalles).

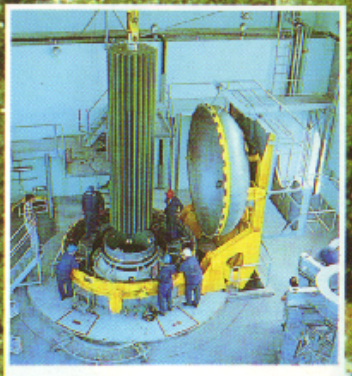
Environment testing centre for rocket motors (SNPE – Saint-Médard-en-Jalles).

Ramrocket missile ready for a flight test (photo ONERA).

SOPHISTICATION Because of the great cost of real testing and particularly of flight tests, experimental and numerical simulations are very important for the design of new solid rocket motors.
The left page shows the subscale testing at ONERA of models of the solid boosters for ARIANE 5. This test is designed to evaluate the interaction between the rocket exhausts and the launch pad.

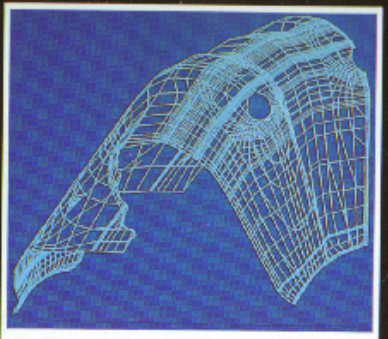


Mandrels of different shapes for molding the bore of solid propellant grains.

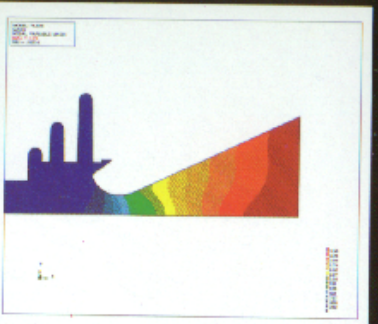


Casting pits for composite propellant for big motors (SNPE – Saint-Médard-en-Jalles).

Modern production plants for solid propellants are more and more specialized, integrated and automatized, at least when the quantities to be produced justify the investment. The right page shows the integrated facility used for the production of MLRS motors (SNPE – Saint-Médard-en-Jalles).



Evolution of a surface in combustion from a tridimensional initial geometry.



Internal flowfield in the propellant cavity and nozzle of a solid rocket motor.

Observation of the combustion of an end-burning solid propellant grain. The "coning" resulting from a higher combustion rate along the inhibitor interface can be observed (SNPE – Le Bouchet Research Center).