Propellants for Missiles , Rockets and Spacecrafts:

Propellant and constituent chemicals for propellants are as follows:

A) Propulsive substances:

(1) Hydrazine (concentration greater than 70%) and its derivatives including Monomethylhydrazine (MMH)
(2) Unsymmetric Dimethylhydrazine (UDMH)
(3) Ammonium Perchlorate
(4) Spherical Aluminium powder (particles of uniform diameter of less than 500 x 10^6 m (500 micrometer) and an Aluminium content greater than 97 %)
(5) Metal fuels in particles sizes less than 500 x 10^6 m (500 microns), (spherical, or atomized or spheroidal or flaked or ground), consisting of 97% or greater of the following : Zirconium, Beryllium, Boron, Magnesium, Zinc and alloys of these ; MISCH metal (alloy of Cerium, Lanthanum, and other rare earth metals) ;
(6) Nitro-amines (Cyclotetratmethylene-Tetranitramine (HMX) , Cyclotetramethylenetrinitramine (RDX) ;
(7) Perchlorates , Chlorates or Chromates mixed with powdered metals or other high energy fuel components ;
(8) Carboranes, Decarboranes, Pentaboranes and derivatives thereof;
(9) Liquid oxidizers as follows :
(i) Dinitrogen Trioxide ;
(ii) Nitrogen Dioxide ; Dinitrogen Tetroxide ;
(iii) Dinitrogen Pentoxide ;
(iv) Inhibited Red Fuming Nitric Acid (RFNA)
(v) Compound composed of fluorine and one or more o0f other halogens, oxygen or nitrogen.

(B) Polymeric Substances :
(1) Carboxy-terminated Polybutadiene (CTPB)
(2) Hydroxy-terminated Polybutadiene (HTPB)
(3) Glycidyl Azide Polymer (GAP)
(4) Polybutadiene Acrylic Acid (PBAA)
(5) Polybutadiene-Acrylic Acid-Acrylonitrile (PBAN)

(C) Composite propellants including Moulded Glue propellants and propellants with nitrated bonding.

(D) Other high energy density propellants such as Boron Slurry, having an energy density of 40 x 10^6 joules/kg or greater.

(E) Other propellant additives and agents :

(1) Bonding agents as follows :
(i) tris(1-(2-methyl)aziridinyl)phosphine oxide (MAPO)
(ii) trimesoyl-1(2-ethyl)aziridine (HX-868 BITA)
(iii) 'Tepanol' (HX-878) , Reaction product of of Tetraethylenepentamine , Acrylonitrile and Glycidol .
(iv) 'Tepan' (HX-879) . Reaction production of Tetlenepentamine and Acrylonitrile ;
(v) Polyfunctional Aziridene Amides with isopthalic , trimesic , isocyanuric, or trimethyladipic backbone having a 2-methyl or 2-ethyl aziridene group (HX-752, HX-874 , HX-877)

(2) Curing agents and catalysts as follows :
(i) Triphenyl Bismuth (TPB)
(ii) Isophoron Di-isocyanate (IPDI)

(3) Burning rate modifiers as follows :
(i) Catocene
(ii) N-butyl-ferrocene
(iii) Butacene
(iv) Other Ferrocene derivatives

(4) Nitrate esters and Nitrato plasticizers as follows :
(i) Triethylene Glycol Dinitrate (TEGDN)
(ii) Trimethylolethane Trinitrate (TMETN)
(iii) 1,2,4-Butanetriol Trinitrate (BTTN)
(iv) Diethylene Glycol Dinitrate (DEGDN)

(5) Stabilizers as follows :
(i) 2-Nitrodiphenylamine ;
(ii) N-methyl-p-nitroaniline

Note 1 : The servo valves for the propellants have flow rates of 24 litres per minute or greater, at an absolute pressure of 7,000 kPa (1,000 psi) or greater, that have an actuator response time of less than 100 msec ;
Note 2 : The pumps, for liquid propellants, have shaft speeds equal to or greater than 8,000 rpm or with discharge pressures equal to or greater than 7,000 kPa (1,000 psi)
Note 3 : The solid or liquid propellant rocket engines have a total impulse capacity of 8.41 x 10^5 Ns (1.91 x 10^5 lbs) or greater .
Note 4 : Ceramic composite materials (dielectric constant less than 6 at frequencies from 100 Hz to 10,000 MHz) , produced by wet-spinning of refractory ceramics (such as aluminium oxide), are used in missile radomes , and bulk machinable silicon-carbide reinforced unfired ceramic are used for missile nose tips.
Note 5 : Fine grained recrystallized bulk graphites (with a bulk density of at least 1.72 g/cc measured at 15 degrees C) and pyrolytic or fibrous reinforced graphites are used to manufacture rocket nozzles and RV (Re-entry vehicle) nose tips . Missile body is manufactured from : Resaturated pyrolized (ie carbon-carbon) materials, composite structures, laminates, including resin impregnated fibre prepegs and metal coated fibre preforms, made either with organic matrix or metal matrix utilizing fibrous or filamentary reinforcements having specific tensile strength greater than 7.62 x 10^4 m (3 x 10^6 inches) and specific modulus greater than 3.18 x 10^6 m (1.25 x 10^8 inches) . Polymeric fibres (such as Polyacrylonitrile , Rayon or Polycarbosilane) are heated and strained to produce the fibrous and filamentary materials. Also Maraging steels (having high nickel, very low carbon contents ; age-hardened), in the form of sheet, plate and tubing, having ultimate tensile strength of 1.5 x 10^9 Pa or greater (measured at 20 degree C), with a wall or plate thickness equal to or less than 5 mm (0.2 inches), are used for manufacturing missile structure systems.
Note 6 : Rocket nozzles and re-entry vehicle nose tips are made of structural composites manufactured by densification of materials formed by pyrolysis of precursor gases, which are deposited on a mould, mandrel or other substrates. Pyrolysis is done at 1300 degree C to 2900 degree C, at 130 Pa (1 mm Hg) to 20 kPa (150 mm Hg) . Isostatic presses, are used for this process, having working pressure of 69 MPa or greater, which are designed to achieve and maintain a controlled thermal environment of 600 degree C or greater, and possessing a chamber cavity with an inside diameter of 254 mm (10 inches) or greater. Chemical vapour deposition furnaces are also used , which are designed for the densification of carbon-carbon composites.
Note 7 : Tungsten , molybdenum and alloys of these metals , in the form of uniform spherical or atomized particles of 500 micrometer diameter or less, with greater than

97% purity, are used for fabrication of missile motor heat shields, nozzle substrates, nozzle throats and thrust vector control surfaces.

Note 8 : The accelerometers, for use in inertial navigation systems or in guidance systems, must have threshold less than 0.05 g, and a linearity error within 0.25 % of full scale output .Gyro-astro compasses are used to derive position or orientation by automatically tracking celestial bodies or satellites. The gyros must have a rated drift rate stability of less than 0.5 degree (1 sigma or rms) per hour in a 1 g environment. Continuous output accelerometers and the gyros must function at acceleration levels greater than 100 g.

Note 9 : Radiation hardening testing must be performed with radiographic equipment capable of delivering electromagnetic radiation produced by bremsstrahlung from accelerated electrons of 2 MeV or greater, and by radioactive sources of 1 MeV or greater.

Note 10 : Thrust Vector Control (TVC) in missile is achieved by flexible nozzles, fluid/secondary gas injection, thrust tabs and deflection of exhaust gas stream (jet vanes or probes)

Note 11 : Terrain contour mapping, scene mapping and correlation (digital and analogue), Doppler navigation radar and imaging sensing equipments (active + passive) equipments are used for avionics