QUALITY

SNFA®

SUPER PRECISION BEARINGS

AEROSPACE, SPACE, HIGH TECHNOLOGY AND SPECIAL APPLICATION

QUALITY

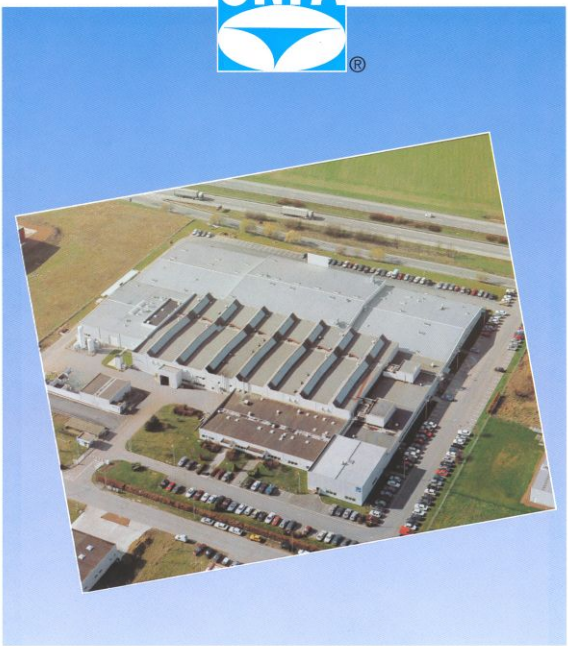
SNFA®

Leading European Supplier of aircraft bearings
and
World Leader for high technology special bearings

Evolution and Innovation

QUALITY

SNFA®



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based in Europe, present worldwide

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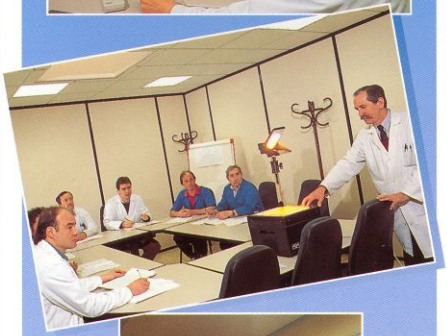
QUALITY

SNFA®

THE COMPANY

A positive and dynamic organisation

Evolution and Innovation



ALWAYS LISTENING TO OUR MARKET AND RESPONDING QUICKLY TO CUSTOMER NEEDS.

Constantly refining and updating our methods of analysis, design and means of production to respond better to our customer's needs.

RESEARCH, INNOVATE AND CREATE TO RESOLVE TODAY THE PROBLEMS OF TOMORROW.

For 40 years we have remained at the forefront of technology, constantly improving product performance. To achieve this we have developed powerful methods for reseach, design and analysis. This constant improvement is recognised and valued throughout the world.

IMPROVE QUALITY AND REDUCE PRODUCT COST AND CYCLE TIME.

We have made considerable investment in numerically controlled machine tools. Our ultra-modern factory in Valenciennes (France) enables us to make products of the highest quality at low cost and reduced lead-time.
In this respect we have created cells for synchronous manufacturing to reduce cycle times.

CREATE A TEAM TO INVOLVE AND BROADEN THE EFFECT OF QUALITY IN THE WORKPLACE.

Men, women, motivated, conscientious, aware of the importance of their work, studying, making, inspecting the products we make. Our sales staff are all engineers, constantly at your call throughout the world.
We are equipped with modern tools at all levels and have programs of training and internal communication.

COMMUNICATION AND EXCHANGE WITH YOUTH ORGANISATIONS AND UNIVERSITIES FOR THE PROFIT OF ALL.

In the course of research and development to improve our products, we are working with universities, laboratories and research centres which have the necessary expertise.

SNFA®

A STRATEGIC
location for easy access to the French and European market

Proximity to the highway and 2 international airports allows easy and fast service.

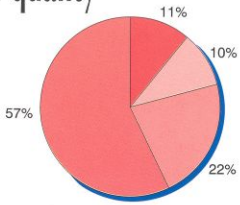
CREATIVITY AND KNOWLEDGE
from competent and experienced engineers and technicians at all levels.

A METHODOLOGY
of high performance. Adaptive, renewable and in permanent position for maximum gain in quality and productivity.

QUALITY ASSURANCE
flowing from training and motivation of the staff. A permanent and vigilant control and investment in the best quality methods.

SERVICE
a commercial staff to carry out their functions under the guidance of our technical service staff and always listening to the customer. Constantly striving to achieve quality, rapidity and support of the customer.

service and quality



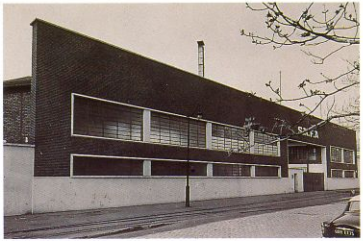
Manufacturing facility for aircraft special bearings, with a floor area of 15 000 square metres.

Staff breakdown as follows :

- 11% are research and development,
- 10% are quality assurance,
- 22% are commercial and administrative,
- 57 % are production.

a dynamic company

Since 1953, the date of its creation, our company has constantly evolved. This is due to the competence and dynamic nature of our workers, technicians and engineers. It is also a result of our special investment policy. These conditions create a natural evolution of the quality of our products. This mandate is carried by our national and international sales force.



Above - our current plant in Valenciennes.

Opposite - our first plant in Ivry.

SNFA experience and applications

Our special bearings are used in many aviation programs worldwide - aircraft, helicopters and missiles. The main applications are turbine engine main shafts and accessory gearboxes, helicopter transmissions and rotors and other aircraft mechanical equipment such as APU.

Examples :

AIRCRAFT ENGINES :

- Missiles :TRS18, TRI60, TRI60-30, ARBIZON.

- Turboprops : ASTAZOU, BASTAN, TP 319, TP 333, PT 6, PW 100, T56, TYNE, AE 2100, TPE 331, TPF 351-20, PW 150.

- Turboshafts : ARRIEL, ARRIUS, ARTOUSTE, ASTAZOU, GEM, MAKILA, PT 6T, PW 200, RTM 322, MTR 390, T 800, TM 333, TURMO III, ARRIEL 2, TV2-117

- Turbojets and Turbofans : AUBISQUE, ADOUR, ARBIZON, ATAR, M 53, M 88, CFM 56, CF 6, F 404, J 57, JT 15D, PW 300, TFE 731, TFE 1042, F 109, LARZAC, MARBORE, TRS18, CFE 738, TRENT, AE 3007.

HELICOPTERS :

- A 109, A 129, AB 204, AB 206, ALOUETTE, DAUPHIN, ECUREUIL, EH 101, GAZELLE, LAMA, PUMA, SUPER PUMA, SEAKING, TIGER, EC 120, EC 135, NH 90, ALH.

OTHER APPLICATIONS :

- Starters : EFA, EMERAUDE, JAGUAR, JAS 39, NOELLE, SOLENT, LCA.

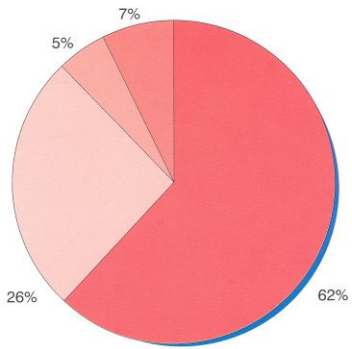
- High Speed Pumps : ADOUR REHEAT, RB 199, HM 7, VIKING, VULCAIN, HIPPAG.

- Auxilliary Power Units : ARGO, AST 600/950, GEVAUDAN, GTCP 85, GTCP 331, GTCP 36, OREDON, RUBIS, SAPHIR, APS 3000, PW 901.

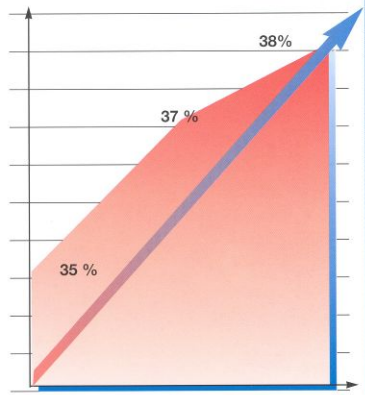
- Aircraft accessory gearboxes : MIRAGE, RAFALE, ATL 2, LCA, F-15.

-Satellites,
-Industrial Turbines,
-Lubrication Pumps,
-Guidance and Tracking systems,
-Radars,
-Formule 1 racing cars.

SALES BY PRODUCT FAMILY



PERCENTAGE OF EXPORTS



our strategy, results...

SNFA is synonymous with performance.

Our many contacts throughout the world enable us to evolve constantly in the most important technologies.

SALES BY PRODUCT TYPE :

- Turbine mainshafts and gearboxes **62%**
- Helicopter transmissions and rotors **26%**
- Starters and accessories **7%**
- Turbopumps, radars, control systems, etc. **5%**

EXPORT SALES :

We are continually improving our export sales and providing technology to our overseas customers.

QUALITY

SNFA®

TECHNICAL CAPABILITIES

constantly improved to ensure optimum quality of our products

Evolution and Innovation

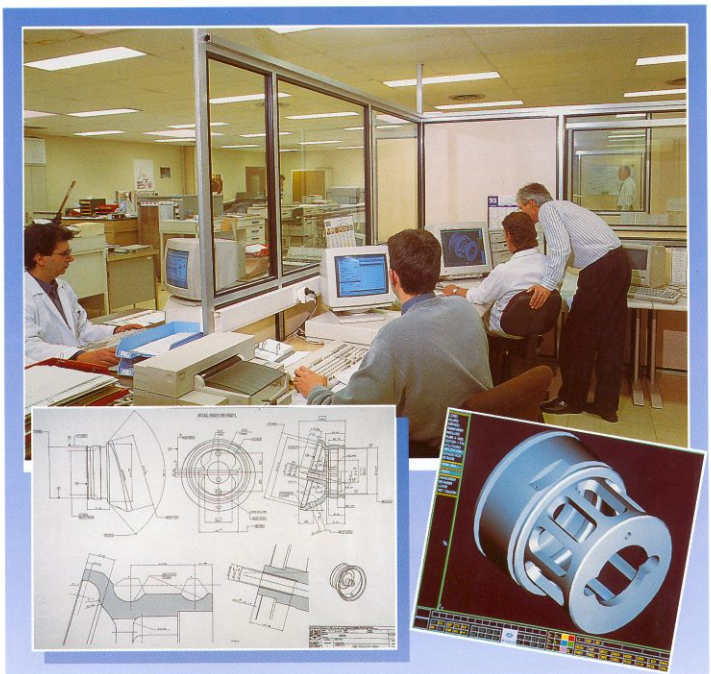
bearing design and analysis...

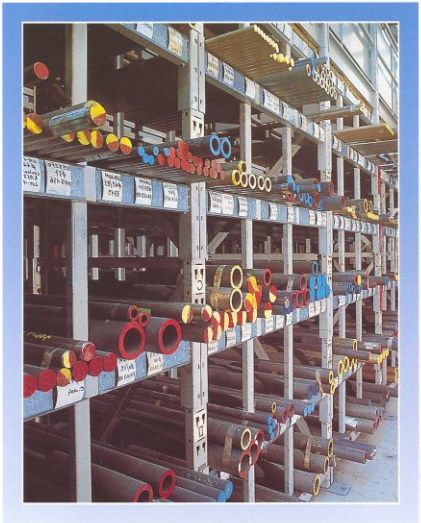
All applications and bearing designs are studied by experienced specialists.

Our engineers and technicians use analysis methods such as the following computer programs.
- ACORD-RMS4.0, / ball bearing analysis for 2, 3 and 4 points of contact.
- ACORD-CAROL 2.0 / For cyclindrical roller bearings,
- ACORD-RODYN / Fully dynamic analysis for ball bearings.
- PKG-ADORE / Fully dynamic analysis for ball and roller bearings.
- ACORD-2D / For finite elements calculation

Bearing design is made on CAD-3D using Matra Data Vision EUCLID. The Design Department has 8 Workstations (SUN ULTRA SPARC). To reduce time and paper, we can communicate directly with customers using the IGES and SET international standards.

In collaboration with universities, we are developing an Expert System to improve design capability.





materials

The operating conditions of each application decide the choice of materials to be used in the bearing.

The table below indicates materials currently used in various applications.

NOTES FOR TABLE

(1) The application may satisfy 1 of these 3 conditions.
(2) Metallic cages, depending on the application, may be silver plated to improve friction characteristics.
(3) This table is not limiting and more variations exist. Our metallurgists are constantly developing new materials.
N.dm : Product of rotation speed in rpm and meam diameter of the bearing in mm.
θ : Operating temperature °C.
Pmax : Maximum Hertz stress in the contact between rolling elements and raceways.

OPERATING CONDITIONS	MATERIAL (3)		
	RACES	ROLLING ELEMENTS	CAGE (2)
Oil lubrication with : N.dm ≤ 2 Millions (1) θ ≤ 200°C (1) Pmax ≤ 2000 MPa (1)	100C6 (SAE 52100) (AMS 6440) (AMS 6444)	100C6 (SAE 52100) (AMS 6440) (AMS 6444)	Bronze UA10N (AMS 4640) US3ZFe (AMS 4616) PEEK
Oil lubrication with : N.dm >2 Millions (1) θ >200°C (1) Pmax >2000MPa (1)	E 80DCV40 (AMS 6491) (AISI M 50) E 13DCNV40 (AISI M50 NIL)	E 80DCV40 (AMS 6491) (AISI M 50) Ceramic Si_3N_4	Bronze or steel 40NCD7 (AMS 6414) (AMS 6415)
Oil lubrication with corrosive environment	Z100CD17 (440C) (BG 42) (AMS 5749)	Z100CD17 (AISI 440C) Ceramic Si_3N_4	Bronze or steel PEEK
Highly corrosive	Stellite N°3 or Alacrite Ceramic Si_3N_4	Stellite N°3 or Alacrite Ceramic Si_3N_4	Carbon
Cryogenic	Z100CD17 (440C)	Z100CD17 (440C) Ceramic Si_3N_4	Teflon composite
Space	Z100CD17 (440C)	Z100CD17 (440C) Carbide	Composite bronze lead Steel+Ag+MOS_2
High bending or torsion loads not favouring through - hardened steels.	Carburising steels 10NCD13 (AMS 6265) 16NCD13 (AISI 9515) Z20WC10 (RBD) E 15DCNV42N (AISI M 50 NIL) Nitriding steel E 32CDV13	100C6 (52100) or E 80DCV40 (M50) or Z100CD17 (440C)	Bronze or steel
High centrifugal loads on rolling elements	E 80DCV40 (M50)	Ceramic (Si_3N_4)	Bronze or steel
No lubrication	E 80DCV40 (M50) Ceramic Si_3N_4	Ceramic (Si_3N_4)	Carbon composite Super Alloy

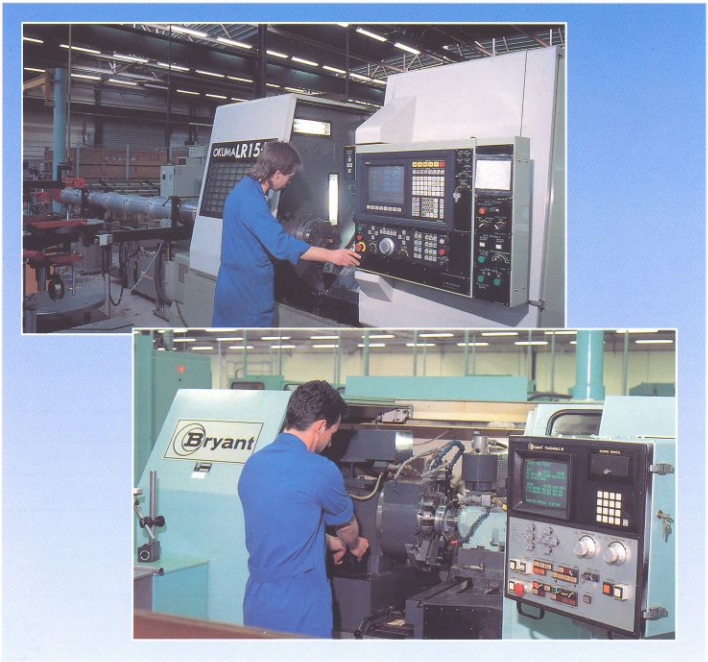
manufacturing machinary...

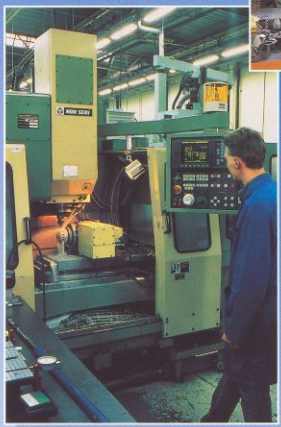
The manufacture of high quality products requires the use of machines capable of adapting to the evolution of technology.

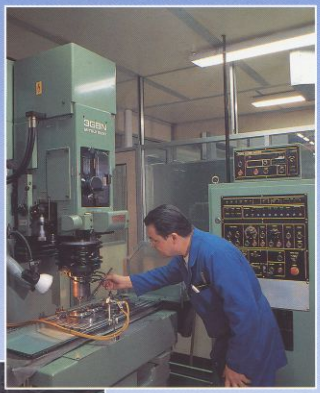
Process sheets are created by computer, as are the programs for the C.N.C. machines.

Our machining capability comprises 200 machines for material removal, mainly automatic, of which :
- 31 turning machines (23 C.N.C.),
- 6 milling machines (4 C.N.C.),
- 3 machining centers 4 axes,
- 26 drilling machines, (14 C.N.C.)
- 6 broaching machines,
- 80 grinding machines (45 C.N.C.),
- 20 superfinishing machines (5 C.N.C.).

Below, an automatic bar device lathe and a Bryant C.N.C. Grinder.





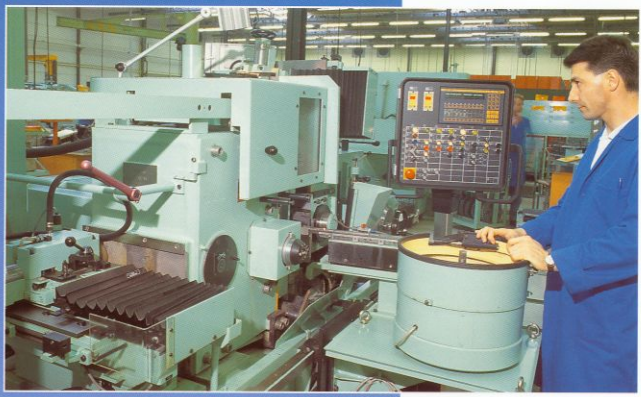


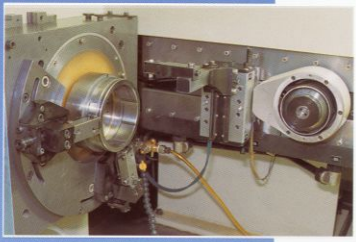
Farretto Grinder

Mori Seiki machining centre

Mitsui Seiki coordinate grinder

Koyo roller face grinder.



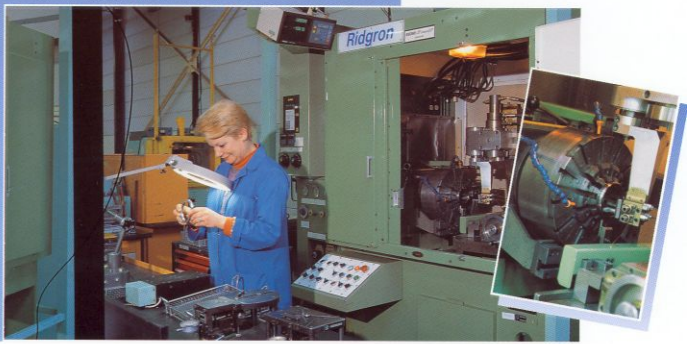


Microsa centerless grinder

Raceway superfinishing

Ridgron Superfinishing machine (SNFA)

Detail of Ridgron.



heat treatment...

MATERIAL CONDITION

Bearing steels, depending on the reliability required by the application, are supplied in a condition which is a function of level of impurity fatigue resistance.

- Vacuum degassed : VD (DSV)
- Electroslag remelt : ESR (RSL)
- Consumable electrode vacuum remelt : CEVM (ESV)
- Double vacuum remelt : VIMVAR (DFV)

HEAT TREATMENT

All heat treatment is carried out internally at SNFA. Our treatment gives our bearings excellent wear and fatigue resistance, as well as dimensional stability. Research and analysis of these qualities enables us to optimise material hardness, both for through-hardened steels (52 100, M 50 and 440 C) and for case-hardened steels.

Also, the operating temperature conditions may determine the choice of heat treatment and therefore the level of hardness.

The following special heat treatments, adapted to the operating conditions, can be performed :

TABLE OF MINIMUM HEAT TREATMENT VALUES

MATERIAL	MAXIMUM OPERATING TEMPERATURE	MINIMUM HARDNESS
100C6 SAE 52100	150°C 220°C 240°C	61 HRc 58,5 HRc 58 HRc
E 80DCV40 AISI M50 E 32CDV13	350°C 300°	61 HRc 61 HRc
Z100CD17 AISI 440C	130°C 350°C	58 HRc 56 HRc
10NCD13 (AMS 6265) 16NCD13	160°C	670 HV
Z20WC10 (RBD)	350°C	670 HV
M50NIL	350°C	60 HRc
Stellite - Alacrite	550°C	51 HRc
Céramique Si_3N_4	1200°C	1600 HV

On page 17 :

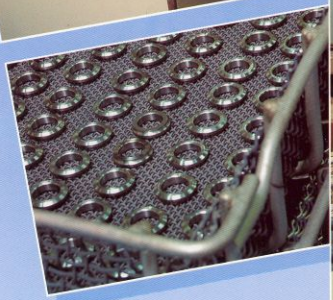
General view of Heat Treatment

On page 18 :

Ensemble of Ipsen Furnaces

Ipsen furnace controller

Furnace entrance



Deep Freeze Treatment

Heat Treatment Lot

Detail of heat treatment chain

Salt Bath

inspection and assembly...

Inspection and measurement are made throughout the manufacturing process and include :

- "material health" inspection,
- non-destructive test.

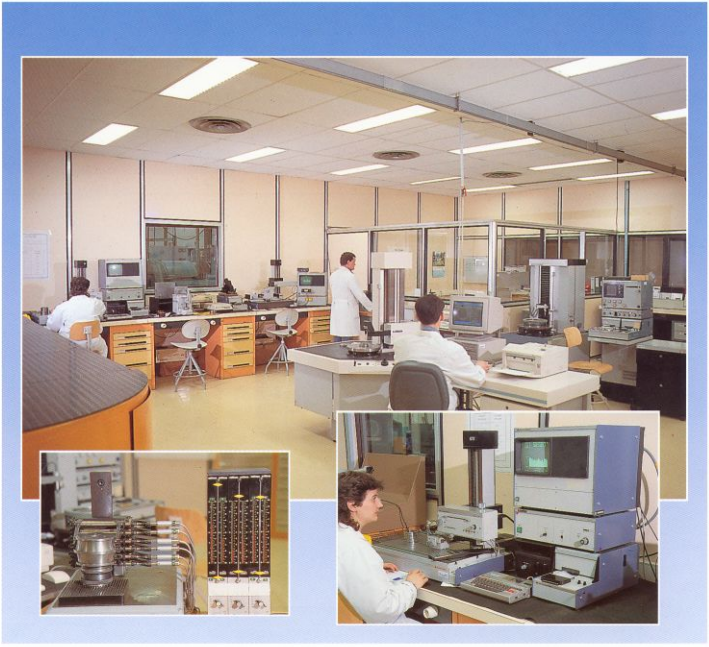
In both cases, the results are recorded on the manufacturing and inspection process sheet.

Also note :

- geometric and dimensional inspection, made on all surfaces, both during and after machining,
- supplementary inspection to satisfy "Quality Assurance",
- first article inspection made on prototypes or first production delivery.

Results are recorded and can, at the demand of the customer, be sent with the product.

Below, metrology room with talyrond 300, talysurf and coordinate measuring machine.



Toroidal MPI

Roller MPI

Nital Etch Inspection

FPI

NON-DESTRUCTIVE TESTING

MAGNETIC PARTICAL INSPECTION (MPI)

MPI is made by sampling in process and 100 % on completed parts. It can detect superficial defects and the following :

- Material defects (inclusions, carbide alignment).

- Heat treatment defects.

- Defects in material transformation (forging cracks, folds).

- Machining defects (grinding cracks, cracks during staking or bending of retention features on cages).

Equipment for Bearing rings

- MPI machines (both standard and toroidal).

Equipement for Rollers
- Automatic MPI machine.

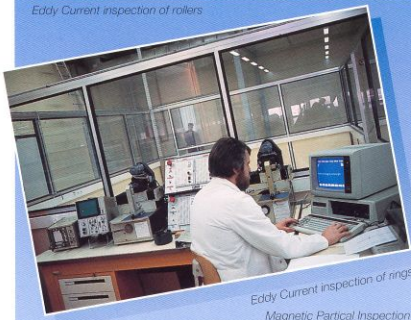
FLUORESCENT PARTICAL INSPECTION (FPI)

FPI on bearing rings and cages allows detection of surface defects.

NITAL ETCH

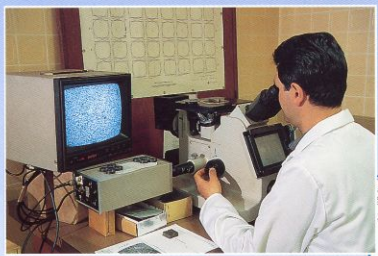
Nital etch is made by sampling in process and 100 %, following customer requirements, on finished parts. This inspection enables us to detect surface defects such as grinding burns as well as evidence of local decarbonising, carbides clusters, carbides aligment and grinding cracks.

Eddy Current inspection of rollers



Eddy Current inspection of rings

Magnetic Partical Inspection



AGREEMENTS

SNFA is qualified by the French Government Quality Assurance department : level RAQ2.

SNFA quality personnels are certified and authorised by some customers to act for them. This fact enable goods to directly enter the customers stocks.

MAGNETOELASTICITY INSPECTION BARKHAUSEN NOISE

Barkhausen Noise generator : STRESSTECH µSCAN 500-1

Proccess used for inspection of :
- microstructures,
- thermochemical treatment,
- residual stress analysis on ferromagnetic components.

EDDY CURRENTS

Inspection is made in parallel with machining to detect metallurgical changes resulting from grind burns. Our equipment comprises :

Rings :

- Eddy current generator,
- capture device for bearing ring,
- data recorder,
- drive system for exploration of the surface.

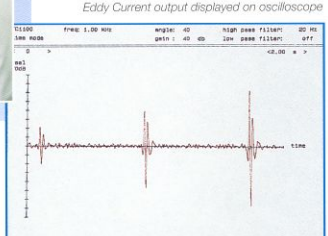
Rollers :

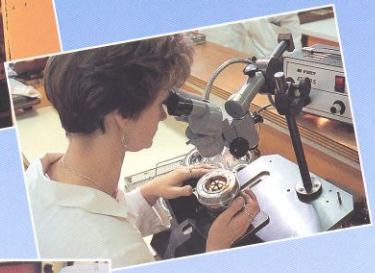
- An automatic feeding and sorting installation comprising :
- Eddy Current generator,
- Roller capture device,
- Data recorder,
- Drive system for exploration of the surface

CONTROL OF SILVER PLATING THICKNESS

This inspection is made on cages with a thickness measuring machine using X-rays. Cages are made from steel or copper alloys.

Eddy Current output displayed on oscilloscope





Assembly room

Riveting of cages

Inspection of rivets.

Noise level inspection

bearing preparation for delivery...

In order to deliver products well adapted to customer needs, we have developed and placed in permanent practise the notion of Quality Assurance.

Our class 1000 clean room contributes to the high level of quality.

The clean room comprises :
- a new technology, automatic washing system with 1µm filtration,
- a preservative application system using oils filtered to 1µm,
- two systems for contamination control, by millipore and by laser.

Below, our clean room and washing machine.

research and development

SNFA takes up the challenge in aviation and space to propose new materials and processes

STEELS

	MECHANICAL STRENGTH	TEMPERATURE PERFORMANCE	CORROSION RESISTANCE
M50 NIL	↗	↗	→
PYROWEAR 675	↗	↗	↗
H.N.S.	↗	↗	↗
E 32CDV13 (deep nitrided)	↗	↗	→

CERAMIC

Speed	↗	Corrosion resistance	↗
Wear resistance	↘	Stiffness	↗
Heat Generation	↘	Operating temperature	↗
Life	↗	Torque	↘
Minimum lubrication	↘	Hardness	↗
Weight	↘	Magnetism	↘

COMPOSITES

SNFA is developing cages using composite materials (PEEK, Vespel, Duroid).

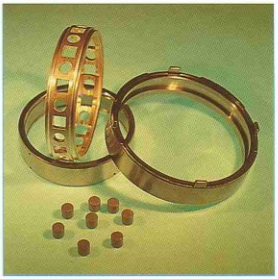
Weight	↘	Heat generation	↘
Operating Temperature	↗	Fatigue resistance	↗
Coefficient of Friction	↘	Self-lubrication	↗
Mouldability	↗	Chemical resistance	↗

COATINGS

- Solid films for dry lubrication : MoS2, MICROSEAL 200 (high speed application) and MICROSLIDE (PVD application)

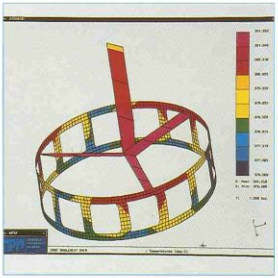
- Thin Dense Chrome coating "Armoloy"

- Titanium Carbide, CVD coating "TIC"

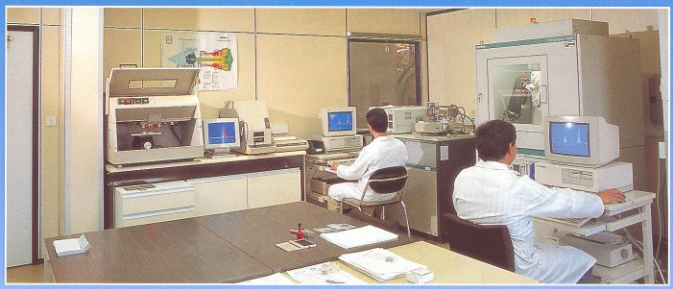


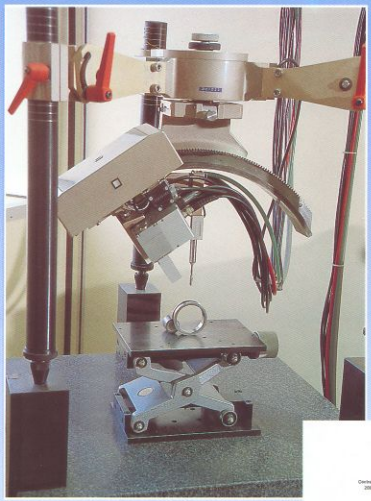
SNUB 45 with ceramic rollers.

Prototype PEEK cage reinforced with carbon and PTFE.



Rheological study for moulding cages in PEEK composite.





RESIDUAL STRESSES

SNFA inspects, by X-Ray diffraction, the level of residual stresses on production of steel rings.

The laboratory has a bank of residual stresses data created for 3 principle materials - 52100, M50 and M50NIL. Stress profiles for all parts are recorded and reproduceable for each material.

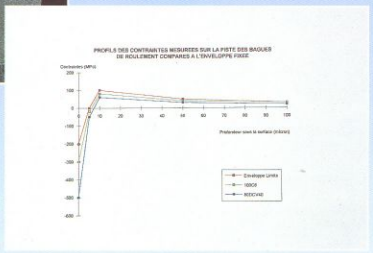
SNFA uses a SET X by Elphyse and a D5000 by Siemens for X-Ray diffraction.

SNFA is able to analyse the surface residual stresses on ceramic rollers.

R and D Laboratory

SET X for measuring residual stress

Residual stress profile.



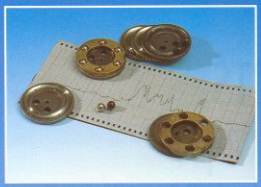
testing...

We attach particular importance to testing.

We have a test bench for bearing materials. The samples are subject to pure axial load. New materials are analysed statistically, under variable contact stress, up to a maximum of 3500 MPa and alternating rotation of 25 Hz.

5 high speed test rigs are operational since1994.
They have the following characteristics :
- 10 test positions - 30,000 rpm,
- axial load up to 500 daN,
- vibration analyser for rig control,
- statistical analyser for comparative life.

Below, our material test rig, high speed test rig and material test sample.



QUALITY

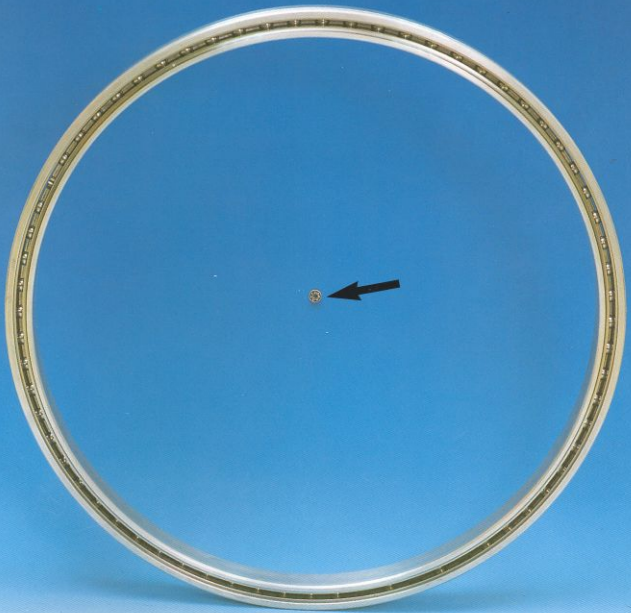
SNFA®

PRODUCTS

SNFA designs, develops and manufactures high precision ball and cylindrical roller bearings for Aircraft and Space applications.

Opposite, 2 examples of bearings of 4 mm inner diameter to 650 mm outer diameter, 3,5 million Nàm in production for M50

Evolution and Innovation



Gas turbine mainshaft bearings

Helicopter transmission, rotor and blade bearings.

Very thin section bearings

Accessory bearings

Various cages of SNFA bearings.

Special integral race assemblies.

OUR TEAM OF ENGINEERS

is at your disposal

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