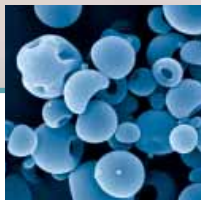


## Niro Pharma Test Station



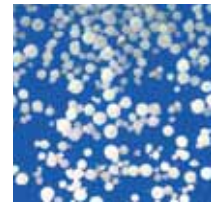
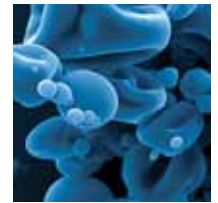
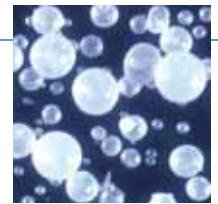
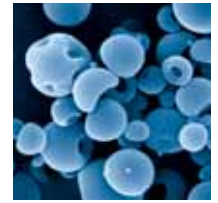
*Niro Technologies*



# The world's most advanced GMP test station for spray drying

The Niro Pharma Test Station is an addition to the well-established Niro Test Center, which is the major competence center for spray drying technology. No one knows more about engineering high-performance powders than the experienced process technologists at Niro.

The Niro Pharma Test Station is the world's most advanced GMP test station for spray drying. It not only helps you refine products and processes under GMP conditions – with minimum development time and maximum security of outcome. It also enables you to limit your upfront investment in spray drying equipment until you're sure you have a viable commercial product.



*The Niro Pharma Test Station is built according to GMP standards for final drug production with a cleanroom for powder collection and process control that is 21 CFR part 11 compliant. It includes two fully equipped spray dryers, a PSD-1 and a PSD-4, both in closed-cycle execution. This allows for realistic full-size testing or generation of data for safe scale-up.*



# 75 years experience at your service

Main control room

As the world's leading supplier of spray dryers, Niro has 75 years experience in spray drying. Furthermore, we've spent more than a decade refining our technology specifically for use within the area of final solid dosage drug forms.

Niro spray drying offers a number of unique advantages for pharmaceutical companies: Bioavailability, encapsulation, aseptic production and inhalation.

*The Niro Pharma Test Station meets the EU's requirements for the production of Investigational Medicinal Products (IMP) and exists exclusively to aid Niro customers in drug development projects. It is approved by the Danish Medicines Agency.*

## Bioavailability

Now you can open the door for new, important treatments that are currently shelved due to low bioavailability. With spray drying you can co-precipitate an API with a polymer in a stable amorphous solid dispersion, thereby greatly improving the dissolution rate of the spray-dried powder. Likewise, nano-particles can be transformed into easy-to-handle powders.

## Modified release

Spray drying as well as spray congealing make it possible to create particles that can fashion specific release patterns and other properties – giving you a variety of commercial and pharmacological advantages. These include prevention of drug concentration peaks, reduced side effects and effective taste masking.

PSD-4 powder collection





### Aseptic production pre-studies

Spray drying offers a number of advantages over traditional methods of aseptic drying such as freeze drying. By providing precise control of the drying process, spray drying gives you far greater command over the shape, density and morphology of the final product. Although the Niro Pharma Test Station cannot offer actual aseptic production, valuable pre-studies can ensure proof of concept and help you decide on appropriate further steps.

### Inhalation

Niro has developed highly specialised spray drying nozzles (patent pending) that give you far greater particle engineering capabilities, even at a large scale, making it possible to accurately manipulate the aerodynamic particle size.

## Floor Plan: Pharma Test Station



# Invest in reliable results, quickly

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Which characteristics are most advantageous for your product? How can a spray drying process be designed to meet your product expectations? Is the process robust? The Niro Pharma Test Station enables you to answer crucial questions about your product and processes and achieve proof of concept quickly and effectively – before you've made a significant investment in production facilities and in-house expertise.

## **Toxicology studies and clinical trials material**

Use the Niro Pharma Test Station to produce material for safety, stability and toxicology studies and clinical trials. The production facilities are fully qualified and approved by the Danish Medicines Agency, and a comprehensive SOP system supports the activities.

## **Small-scale efficiency, full-scale expertise**

The Niro Test Center, which includes GMP as well as non-GMP facilities, encompasses resources ranging from table-top equipment to full-size spray drying

plants. To minimise your costs, we conduct initial testing under non-GMP conditions, using the same type of processes as in the GMP test station. This enables us to refine product and process parameters in a flexible environment.

Because you are able to run full-scale tests, you can also train key personnel and qualify processes while establishing a commercial production unit. This substantially compresses the time used in the "tech transfer" and the switch to commercial production.

*Feed preparation*





PSD-1 drying chamber



PSD-4 chamber cone in cleanroom

## PSD-1

### Plant configuration

- Main components: Chamber, cyclone, bag filter, HEPA-filters, condenser, electrical heater
- Nitrogen as drying gas
- Closed-cycle loop
- Powder collection under cyclone. Bag filter for collecting fines
- Atomization methods:
  - Pressure nozzle, co-current
  - Two-fluid nozzle, co-current

### Feed

- Mixing of various solvents possible
- Dosing and mixing of various raw materials possible
- Filtration of feed possible

### Solvents

- Water
- Ethanol
- Methanol
- Isopropyl alcohol
- Acetone
- Methylene chloride
- Ethyl acetate

### Operating parameters

Inlet temperature	up to 220 °C
Outlet temperature	up to 150 °C
Condenser temperature	down to -18 °C
Feed rate	up to 10 kg/h (depending on solvent type)
Feed temperature	5 °C to 80 °C
Pressure nozzle, atomization pressure	10 bar to 100 bar
Two-fluid nozzle, gas pressure	0,5 bar to 14 bar
Two-fluid nozzle, atomization gas temperature	18 °C to 100 °C

### CIP

- CIP liquid temperature: Up to 80 °C

## PSD-4

### Plant configuration

- Main components: Chamber, cyclone, bag filter, HEPA-filters, condenser, electrical heater
- Nitrogen as drying gas
- Closed-cycle loop
- Powder collection under cyclone. Bag filter for collecting fines
- Atomization methods:
  - Pressure nozzle, co-current
  - Two-fluid nozzle, co-current

### Feed

- Mixing of various solvents possible
- Dosing and mixing of various raw materials possible
- Filtration of feed possible

### Solvents

- Water
- Ethanol
- Methanol
- Isopropyl alcohol
- Acetone
- Methylene chloride

### Operating parameters

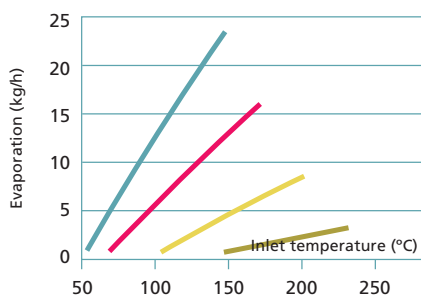
Inlet temperature	up to 220 °C
Outlet temperature	up to 150 °C
Condenser temperature	down to -18 °C
Feed rate	15 kg/h to 400 kg/h (depending on solvent type)
Feed temperature	5 °C to 80 °C
Pressure nozzle, atomization pressure	10 bar to 300 bar
Two-fluid nozzle, gas pressure	0,5 bar to 14 bar
Two-fluid nozzle, atomization gas temperature	18 °C to 100 °C

### CIP

- CIP liquid temperature: Up to 80 °C

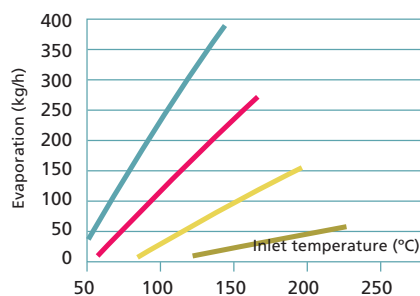
### PSD-1 co-current atomization

Nominal drying gas rate: 80 Kg/h



### PSD-4 co-current atomization

Nominal drying gas rate: 1250 Kg/h



- Methylene Chloride Evaporation Rate at Outlet Gas Temp 40 °C
- Acetone Evaporation Rate at Outlet Gas Temp 50 °C
- Ethanol Evaporation Rate at Outlet Gas Temp 70 °C
- Water Evaporation Rate at Outlet Gas Temp 90 °C

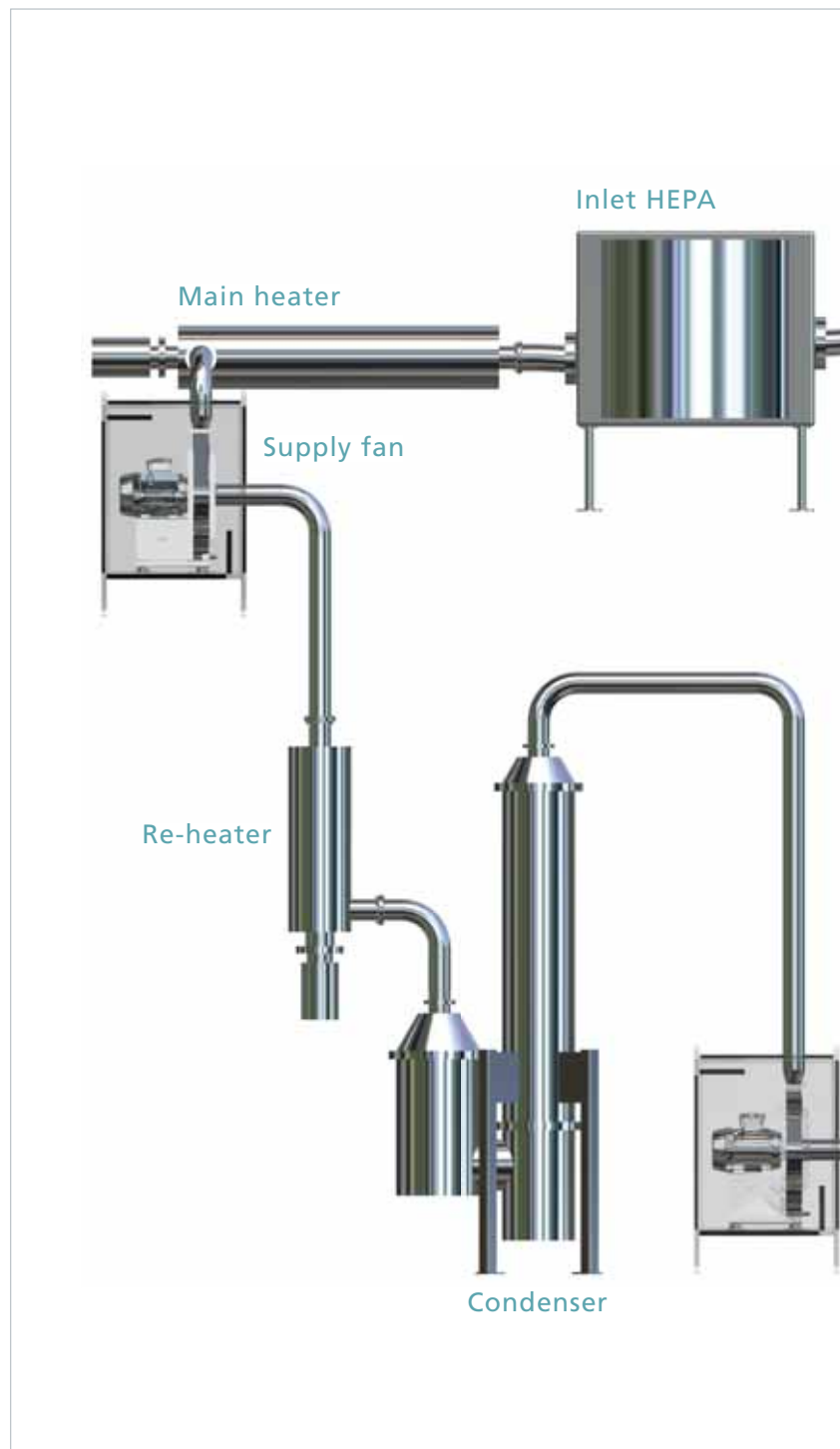
# The spray drying process

Spray drying is a very fast method of drying due to the very large surface area created by the atomization of the liquid feed and high heat transfer coefficients generated. The short drying time, and consequently fast stabilisation of feed material at moderate temperatures, means spray drying is also suitable for heat sensitive materials.

As a technique, spray drying consists of four basic stages:

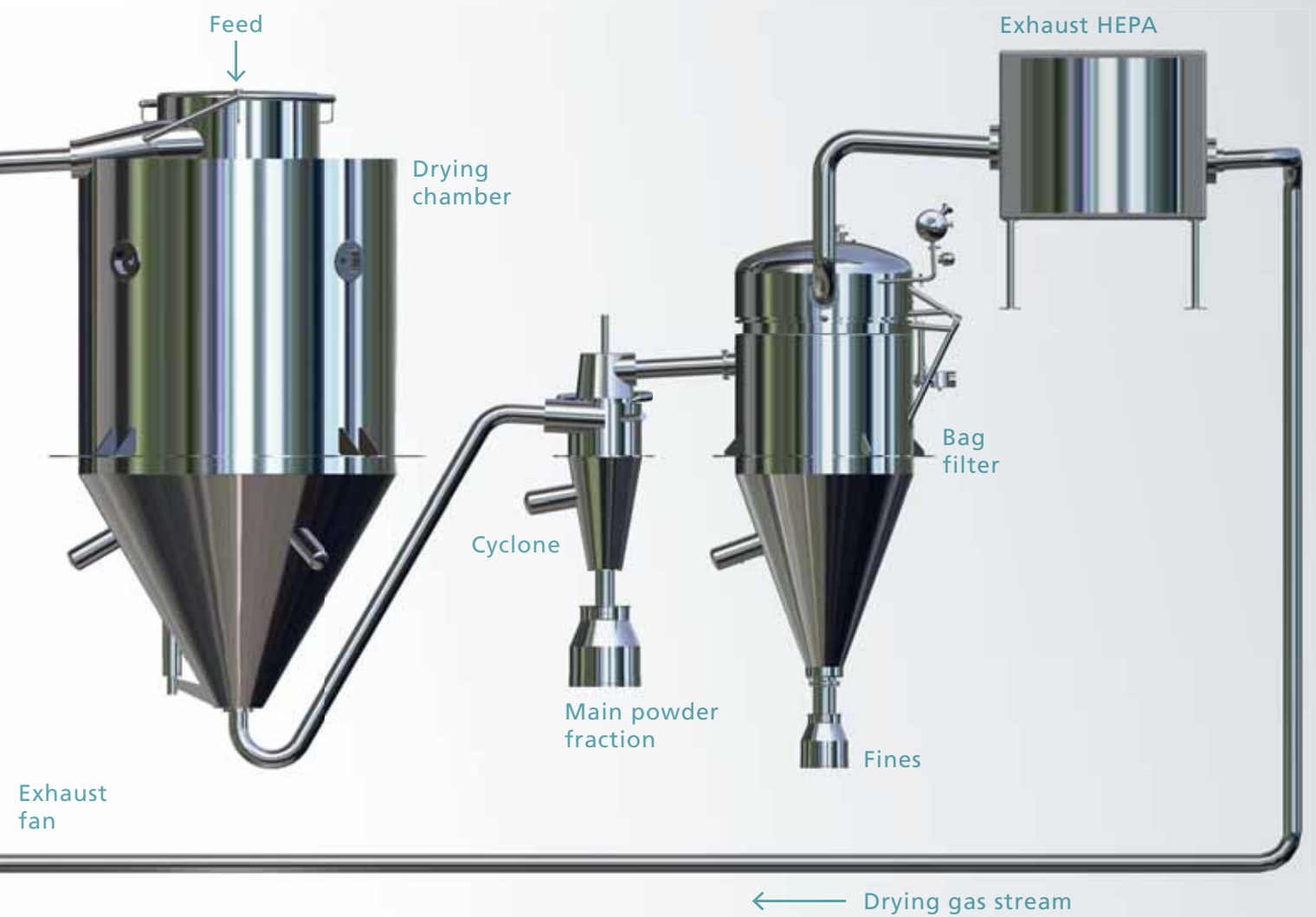
- a. **Atomization:** A liquid feed stock is atomized into droplets by means of a nozzle or rotary atomiser. Nozzles use pressure or compressed gas to atomize the feed while rotary atomizers employ an atomizer wheel rotating at high speed.
- b. **Drying:** Hot process gas (air or nitrogen) is brought into contact with the atomized feed using a gas disperser, and evaporation begins. The balance between temperature, flow rate and droplet size controls the drying process.
- c. **Particle formation:** As the liquid rapidly evaporates from the droplet, a solid particle forms and falls to the bottom of the chamber.
- d. **Recovery:** The powder is recovered from the exhaust gases using a cyclone or a bag filter. The whole process generally takes no more than a few seconds.

## Closed cycle spray drying system





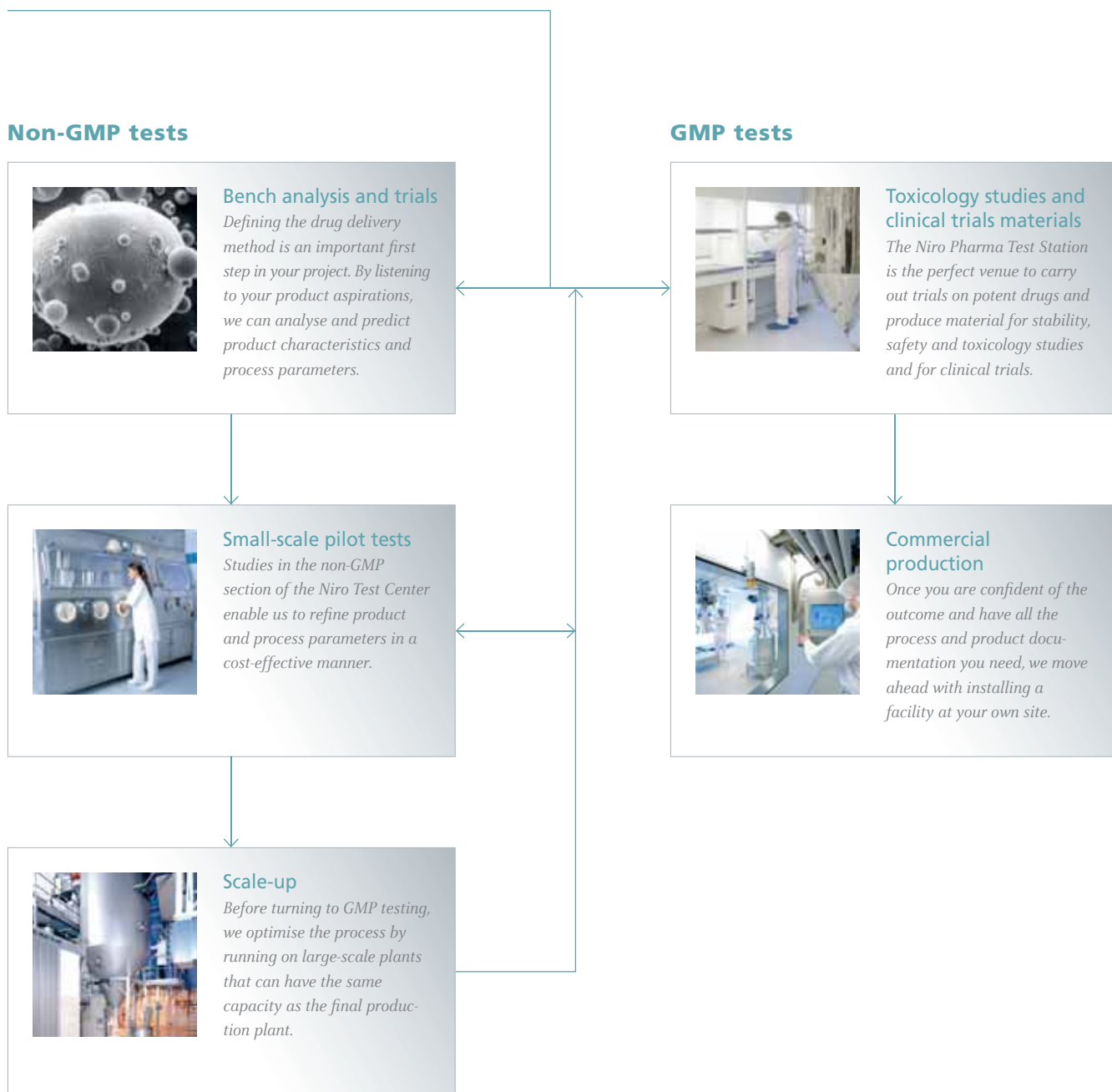
PSD-4 chamber roof with gas dispenser and top of bag filter



# Shorten your drug development cycle

The Niro Test Center includes GMP as well as non-GMP facilities. These facilities allow you to go from the early stages of product development, where only a few hundreds of millilitres of liquid product are available, to the final phases of process refinement, where full-scale testing is possible.

## Development route





PSD-4 chamber and HVAC ducts



CIP tanks



Solvent vapour adsorption and waste water tanks

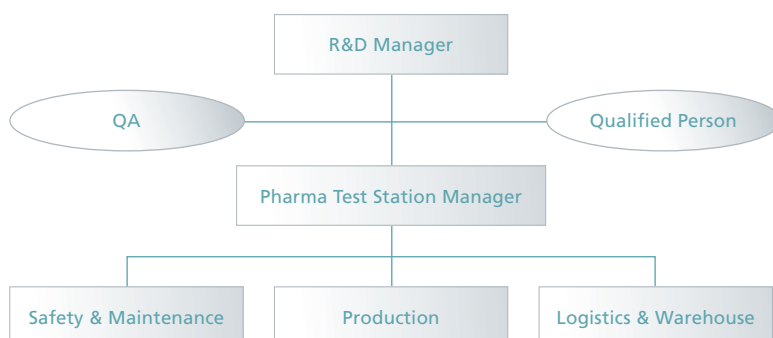
## Communication is critical

At the early stages of a project, the involved parties will sign a confidentiality agreement. Before any testing begins, we work with you to clearly define your project and its goals. Both the customer's and Niro's responsibilities are spelled out, the level of documentation is agreed upon, and basic documentation is established for the development phases. Formal protocols are prepared and approved by both parties before GMP production begins. A typical protocol includes the following:

- **Introduction and time schedule**  
A short introduction to the project.
- **Objective**  
A clear description of the purpose of the trial, leaving no doubt about what to investigate.
- **Safety**  
Material safety data sheets (MSDS) are required before any production can be planned.
- **Responsibility**  
A description of the responsibilities of Niro A/S and of the customer. Who is responsible for equipment, analysis, provision of materials including excipients and solvents, operation methods, decontamination procedure, swab analysis, safety issues, etc.
- **Equipment**  
A description of the selected spray drying system.
- **Methods**  
Batch records, feed preparation, drying conditions, test plan, SOPs.
- **Deviations procedure**  
For reporting deviations from the protocol.



The Niro Pharma Test Station includes a validated purified water production and distribution system. The PW production unit supplies the spray dryer CIP and feed systems with water meeting the pharmacopoeial quality standard.



The organisation of the Niro Pharma Test Station is established to meet the requirements from the authorities and the customers as well as the organisation's operational requirements.





### Central Know-How on a Global Scale

Based on a strong commitment to research and development, pharmaceutical technology centres in Belgium, Denmark, Switzerland, the UK, Singapore, and USA provide global technical support and know-how to the pharmaceutical industry.

These centres of excellence give customers

access to a range of test facilities and expert teams with technical and process know-how. Our teams work closely with our customers to optimise processes and evaluate their products, enabling them to achieve their process and production goals.



### Contracting Profitable Experience

A world leader in supplying pharmaceutical equipment, GEA Pharma Systems offers manufacturers all over the world the opportunity to enter into a profitable partnership for development and contract. GPS combine advanced in-house technology with a thorough

understanding of the pharmaceutical industry to help customers maximize their development results.



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