



THE SCIENCE OF A PURE ENVIRONMENT



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# **PRESENTATION OF NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT**



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## **NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT**

- 0. MAIN CONDENSATE TREATMENT**
- 1. REACTOR WATER CLEAN-UP**
- 2. FUEL POOL CLEAN-UP**
- 3. LOW AND MEDIUM ACTIVITY WATER TREATMENT**
- 4. OFF-GAS TREATMENT**



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# NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

## 0. MAIN CONDENSATE TREATMENT

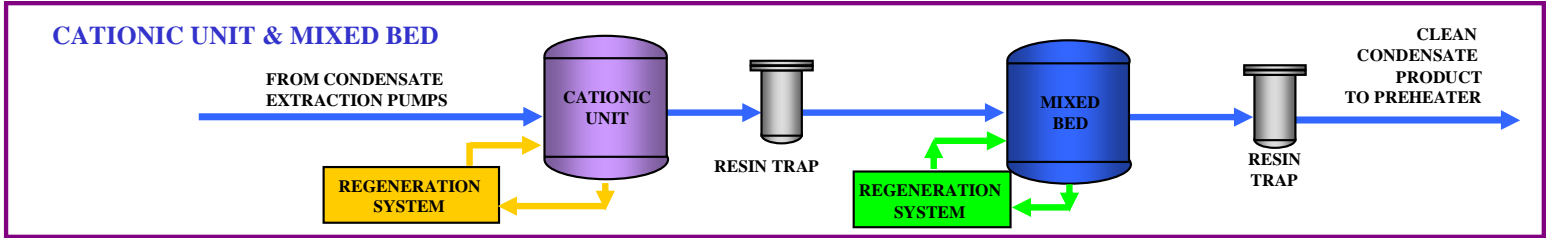
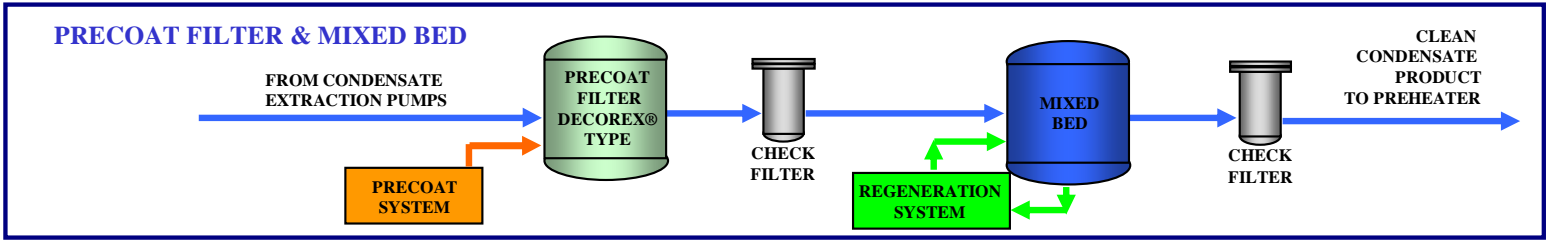
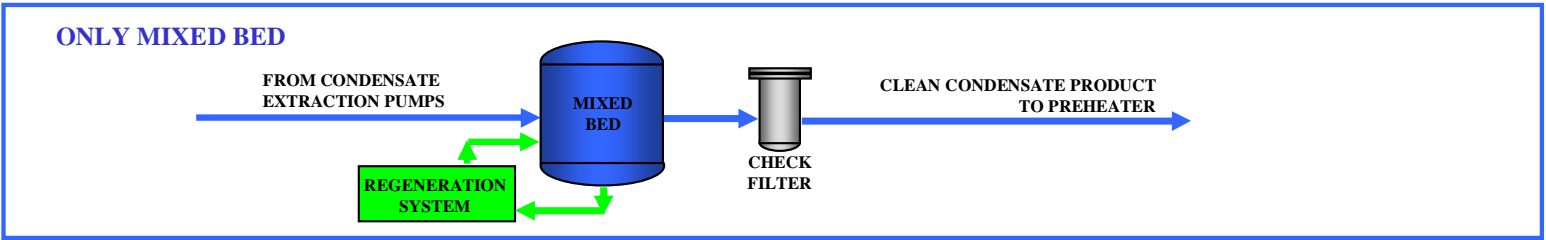
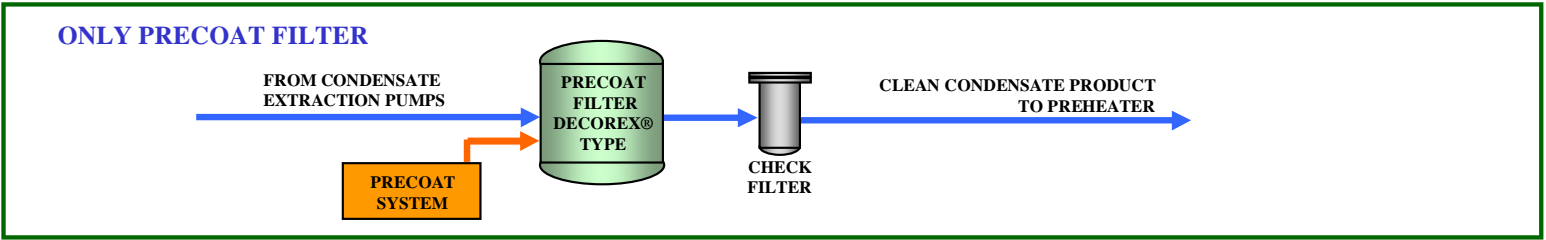
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“CONDENSATE TREATMENT”



**NUCLEAR APPLICATIONS:  
CONDENSATE POLISHING  
PROCESSES**

**TYPICAL FLOW DIAGRAMS**





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## **NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT**

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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 1. REACTOR WATER CLEAN-UP

Reactor water consists on the following:

- *in BWR (Boiling Water Reactors) the hot water in contact with fuel elements*
- *in PWR (Pressurized Water Reactors) the intermediate fluid coming from the reactor and going to the steam generator (secondary circuit)*

Even if the operating and design condition are different, the two technology of reactor water clean-up are similar.



## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 1. REACTOR WATER CLEAN-UP

The reactor water clean-up, treating a radioactive liquid, consists on:

- A) *precoat filters*
- B) *mixed beds without regeneration*
- C) *both systems*

The choice of the treating system depends from the type of reactors and the power plant designer.



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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 1. REACTOR WATER CLEAN-UP

#### A) Precoat Filter

This technology is the same as the one presented above in the main condensate treatment section.

The filtering elements used for this application are always metal type, in order to extend the element life.

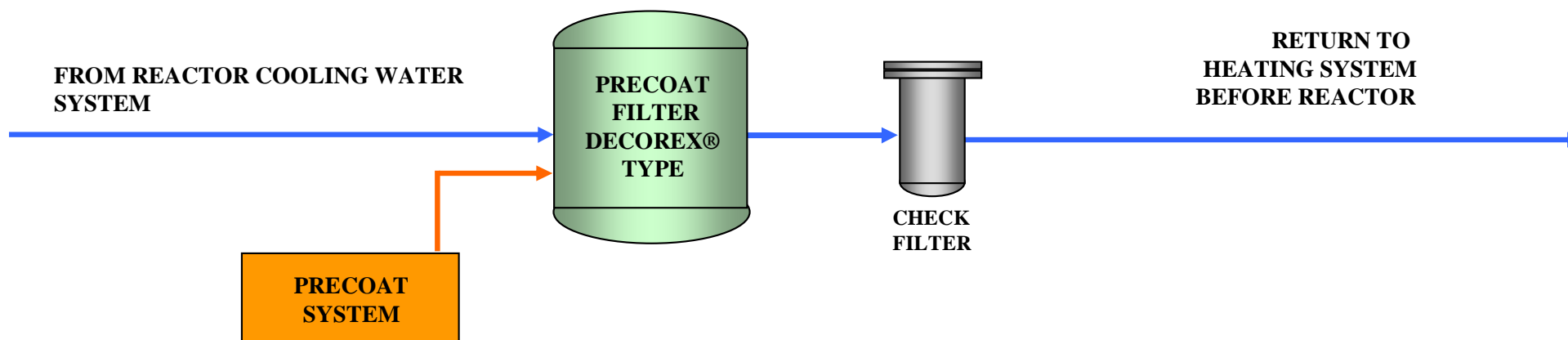
The powdered resins used are in active form and very pure (nuclear grade), avoiding the presence of residual compounds of fabrication that could contaminate the effluent.





# NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

## ONLY PRECOAT FILTER





## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 1. REACTOR WATER CLEAN-UP

#### B) Mixed Beds Without Regeneration

This technology consists on ion exchange units containing strong cationic and strong anionic resin mixed together in active form.

When exhausted, the resin is discharged and replaced with a new charge.

The bead resins used are in active form and very pure (nuclear grade).



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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 1. REACTOR WATER CLEAN-UP

#### B) Mixed Beds Without Regeneration

##### Exhausted Resin Treatment

Exhausted bead resins are discharged from filter units to a phase separator using AIR and DEMI WATER.

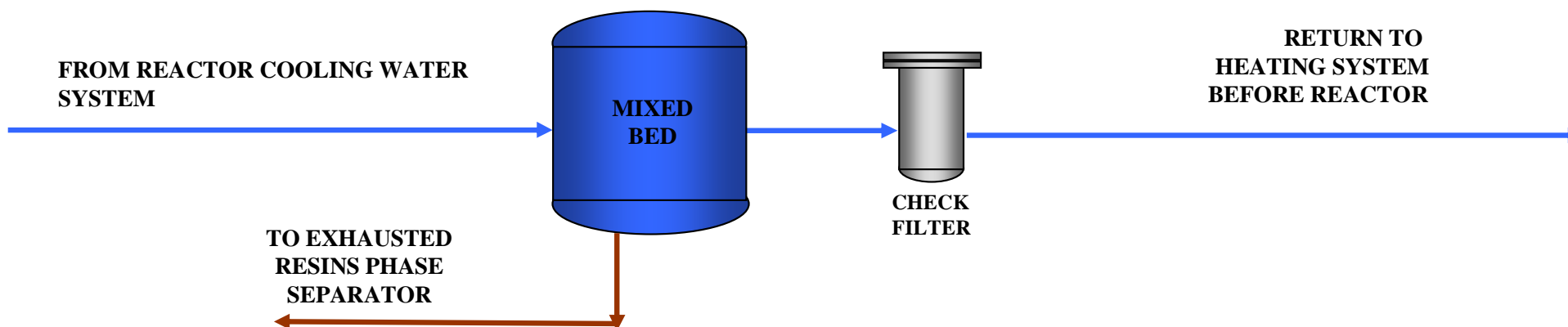
In the phase separator: a settling of solid will take place and the two phases are divided and sent to the final destination:

- *the liquid will reach the light radwaste tank (Medium Activity Water)*
- *the solid will go to the solid radwaste treatment*



# NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

## ONLY MIXED BED (UNREGENERABLE)





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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 1. REACTOR WATER CLEAN-UP

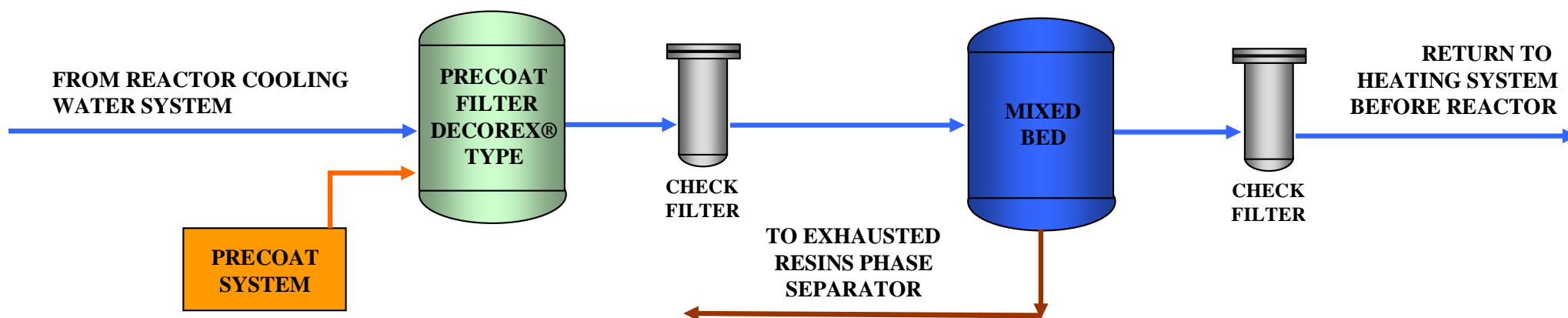
#### C) Precoat Filters + Mixed Bed

In this case, due to the presence of mixed bed as second treatment, the precoat filters can use inert material instead of powdered resin.



## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### PRECOAT FILTER & MIXED BED (UNREGENERABLE)





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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 2. FUEL POOL WATER CLEAN-UP

The spent fuel elements are normally stored in a pool filled with demineralized water, that after needs to be decontaminated.

Decontamination means cleaning from soluble salts and also from the suspended solid matter coming from the ambient.

This purpose is reached by means of precoat filtration using powdered resins nuclear grade. The filtering elements used for this application are always metal type, in order to extend the element life.

After cleaning, water is recycled in the fuel pool.





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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 2. FUEL POOL WATER CLEAN-UP

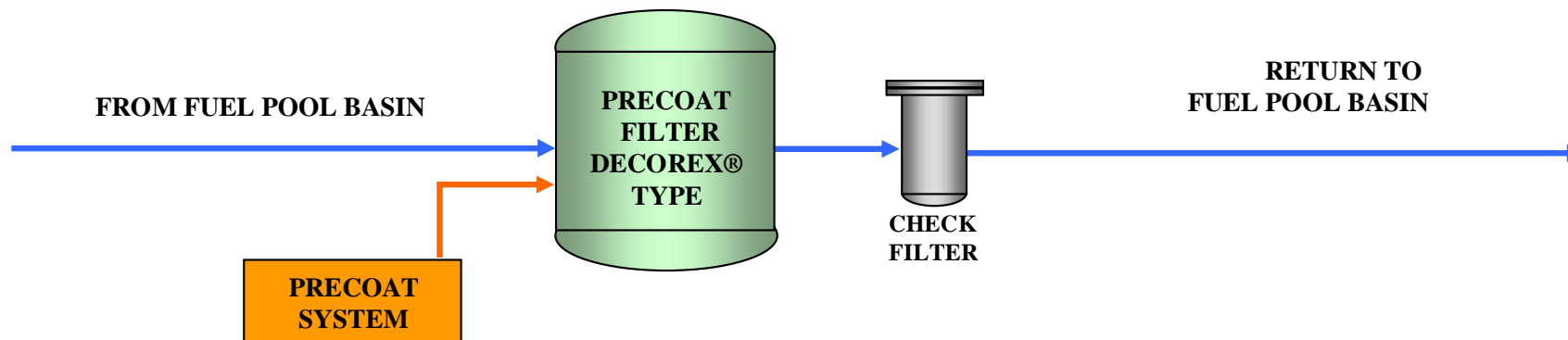
This treatment can be continuous or discontinuous, depending on the pool water characteristics.

Rarely this treatment is performed by means of **mixed bed without regeneration**, as in the reactor water clean-up application above described.

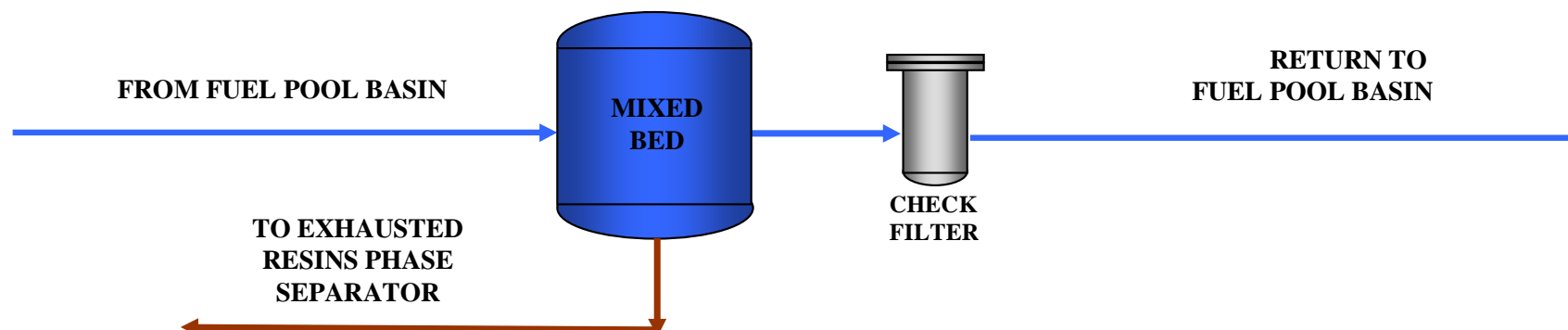


## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### ONLY PRECOAT FILTER



### ONLY MIXED BED (UNREGENERABLE)





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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 3. LOW AND MEDIUM ACTIVITY WATER TREATMENT

LOW ACTIVITY WATER: comes from phase separator of exhausted precoat waste and from the resin final washing in main condensate mixed bed

MEDIUM ACTIVITY WATER: comes from phase separator of exhausted bead resins and from the floor drain cleaning activity. Sometimes comprises some water coming from laundry and from laboratories



## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 3. LOW AND MEDIUM ACTIVITY WATER TREATMENT

#### Low activity water

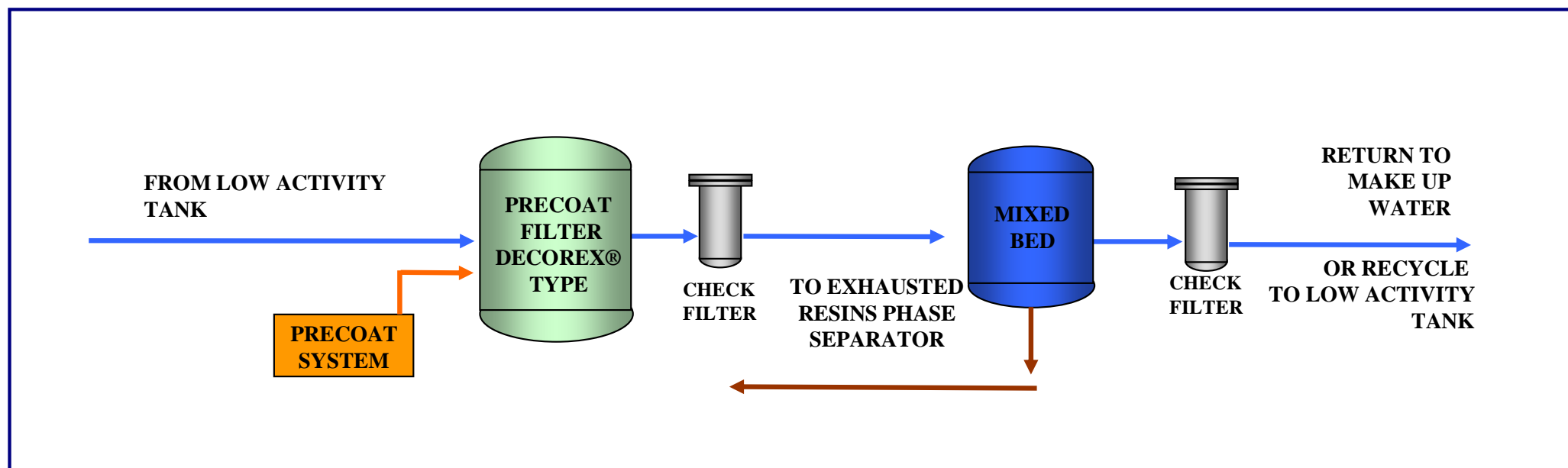
Are usually treated with **precoat filters plus mixed bed** as previously described. The treated water is recycled as demi water make-up.

The exhausted resins are conveyed to the relevant phase separator and the liquid phase comes back to low activity water tank while the resin are fed to the solid radwaste system.



# NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

## A) LOW ACTIVITY WATER





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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 3. LOW AND MEDIUM ACTIVITY WATER TREATMENT

#### Medium Activity Water

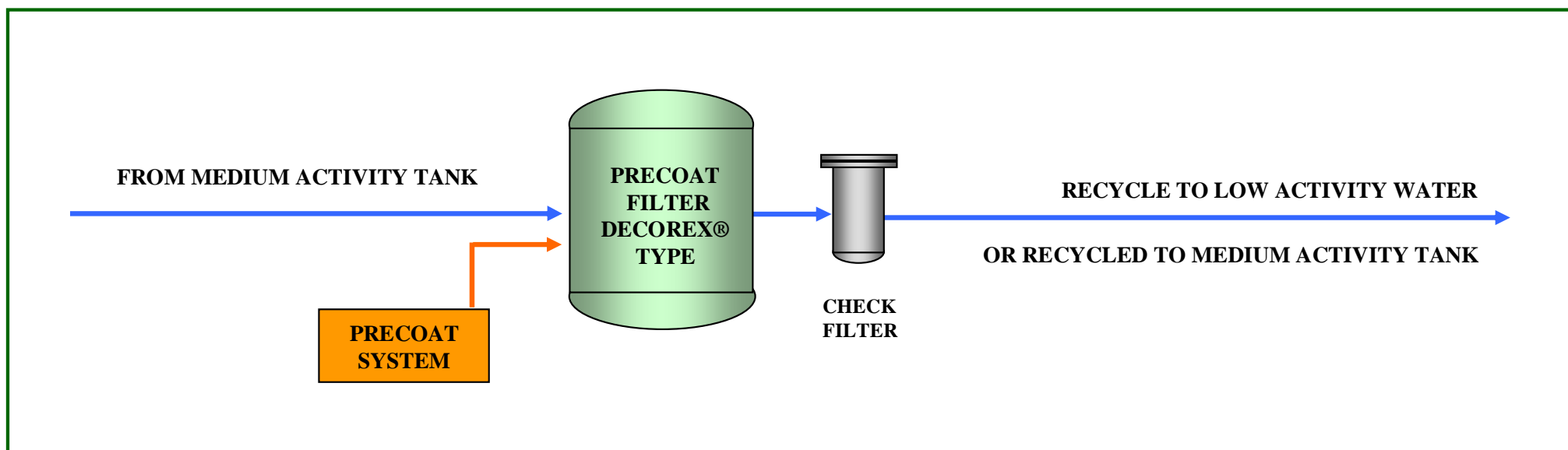
Are usually treated with precoat filters and after testing recycled to the low activity water.

The exhausted precoat is treated as above described.



# NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

## B) MEDIUM ACTIVITY WATER







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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 4) OFF GAS TREATMENT

OFF GAS is the nuclear plant ambient air, which must be cleaned to eliminate radioactive content due to contact with fuel during operations.

OFF GAS consists also in:

- *free hydrogen*
- *traces of radioactive substances such as:*
  - *rare gas deriving from radioactive atoms scission*
  - *radioactive elements*



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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 4) OFF GAS TREATMENT

#### Hydrogen elimination

Performed by means of catalytic recombination:

- Catalyst contained in its own reactor consisting of palladium on a metallic support, generally stainless steel
- Catalyst effectively operates at high temperatures so off gas to be treated is preheated

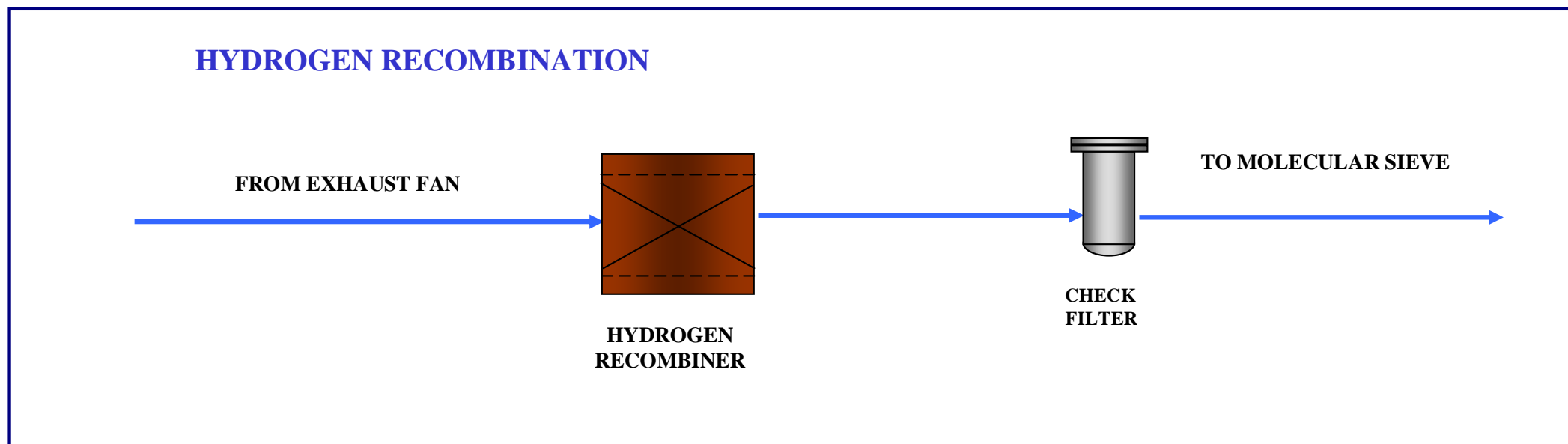


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# NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

## Step 1) HYDROGEN ELIMINATION





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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 4) OFF GAS TREATMENT

#### Radioactive Substances Elimination

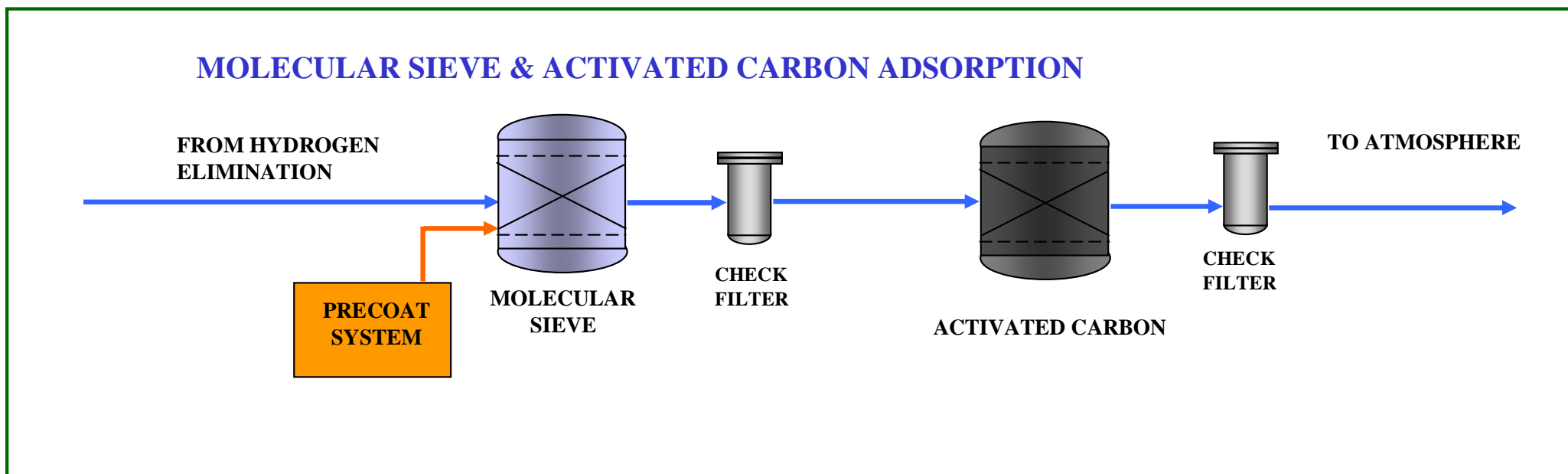
- 1) Rare gas and radioactive elements are eliminated by means of **molecular sieve beds**
- 2) Radioactive elements are eliminated by **active carbon adsorption**

Both molecular sieves and active carbon are included in dedicated filters supported by filtering plates threatening the media.



# NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

## Step 2) RADIOACTIVE SUBSTANCES ELIMINATION





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## NUCLEAR APPLICATIONS OF CONDENSATE TREATMENT

### 4) OFF GAS TREATMENT

Off gas treating plants doesn't traditionally need any important maintenance service and are characterised by the same nuclear power plant life.

Seldom they suffer only from catalyst poisoning, solvable simply by catalyst media substitution.



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***Thank you !***



**STATE OF THE ART TECHNOLOGIES FOR  
NUCLEAR ENERGY APPLICATIONS**