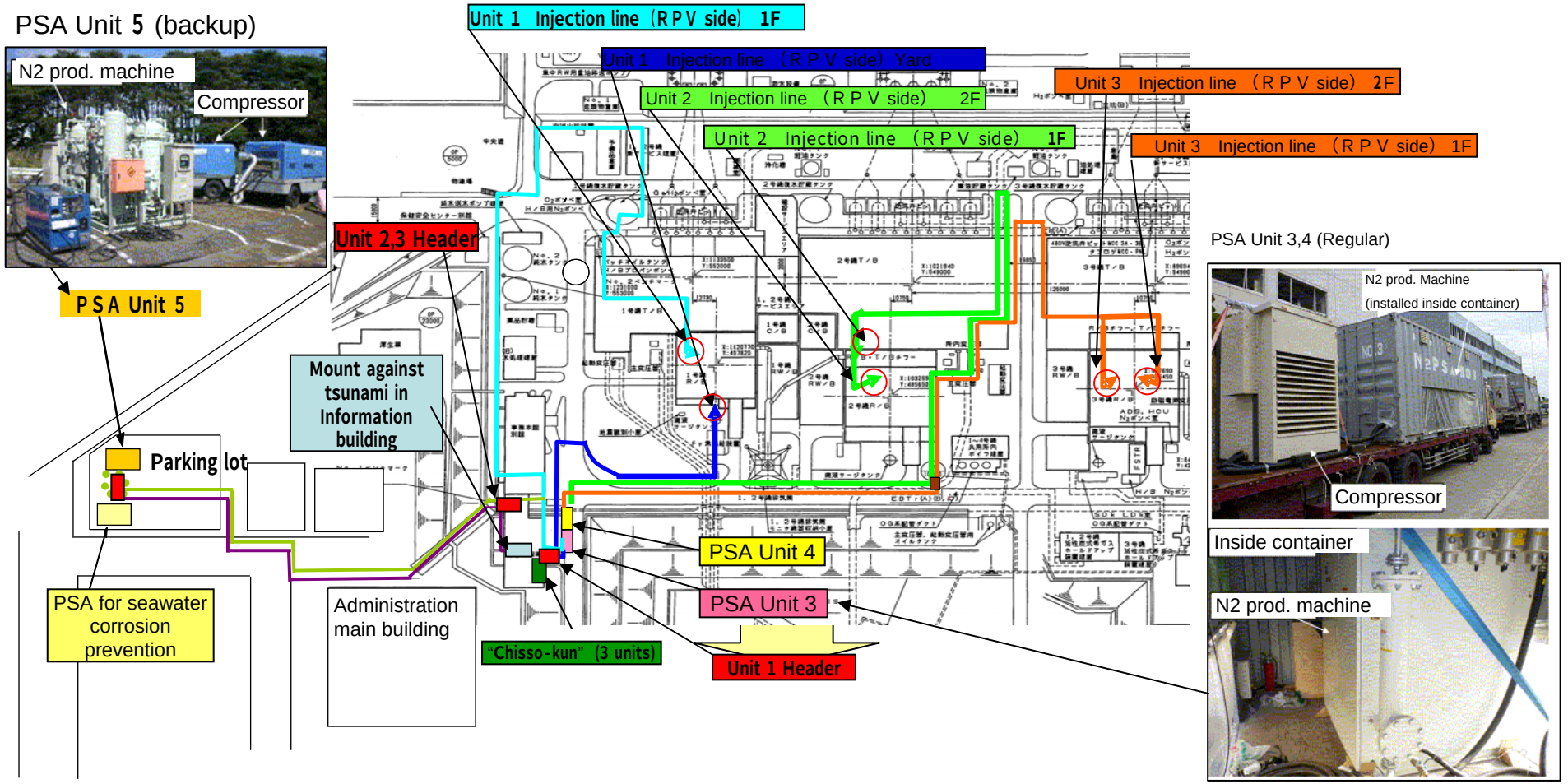
1 The structure of nitrogen gas separator

< R e f e r e n c e >
A p r i l 2 0 , 2 0 1 2
Tokyo Electric Power Company



■ **Nitrogen gas separators (PSA) are operated in a way that one separator is used as regular while the other is used as backup - switching mode - which applies to PSA Unit 3 and 4.**

■ **In addition, nitrogen gas separator driven by D/G (PSA Unit 5) is placed as backup.**

2－1　Description of the trouble of PSA Unit 4 and the corresponding treatment

[PSA Unit 4]

March 12, 2012 Mon. Around 12 pm Confirmed the trip

April 7, 2012 Sat. Around 5 pm Confirmed the trip.

<<The description of the alarm>> --- For both days

◎Confirmed the alarm indication "compressor trouble" at the PSA main monitor.

◎Confirmed "Fan motor over current" at the alarm display of the compressor itself.

<<Treatment 1>>

March 12, 2012 Mon. the time when the countermeasure was implemented.

◎Cleaning of inlet filter and dust filter of the compressor was conducted. Then, the trial operation was done, confirming normal operation.

◎In addition, on March 29, the replacement of lubricant oil of the compressor was conducted. Then continuous running test was implemented for around 3 hours, confirming normal operation.

◎With the trip of PSA Unit 3 on April 4, PSA Unit 4 started operation as regular.

2－1　Description of the trouble of PSA Unit 4 and the corresponding treatment

<<Treatment 2>>

April 7, 2012 Sat. the time when the countermeasure was implemented.

Because the separator stopped its operation with the same event as the one occurred on March 12, Mon, besides the filter cleaning, the following study investigation was implemented:

◎Filter cleaning: Although no contamination was found with the filter itself, fine powder was confirmed on filter casing and others. While collecting these, we prepared manual of filter cleaning, notifying detailed steps and others.

◎Power supply check: For the faciliteis which receive power from house common M/C 1A, which supply electricity to PSA Unit 4, we checked whether any operation which would trigger voltage pulsation, such as start or stop at the time of PSA Unit 4 ‘ s trip. As a result, we found no suspicious event.

◎Fan motor: Meggar measurement: normal result.

Hand turning: normal result.

Inverter inspection: Later we will replace existing one with new one. Then, we will send the former to the factor for further investigation.

2－2　Description of the trouble of PSA Unit 3 and the corresponding treatment

[PSA Unit 3]

April 4, 2012 Wed. Around 11 am, we confirmed the trip.
April 13, 2012 Fri. Around 1 am we confirmed the trip.

<<The descriptionof the alarm>>

April 4, 2012 Wed.
◎Confirmed the alarm indication "compressor trouble" at the PSA main monitor.
◎Confirmed "Over current protection" at the alarm display of the compressor itself.

<<Countermeasure>>

◎Cleaning of inlet filter and dust filter of the compressor was conducted. Then, the separator was rebooted, confirming normal operation.
Due to the heavy wind the day before, the filter was clogged with litter, insects, leaves, and others.

2－2　Description of the trouble of PSA Unit 3 and the corresponding treatment

<<The description of the alarm>>

April 13, 2012 Fri.

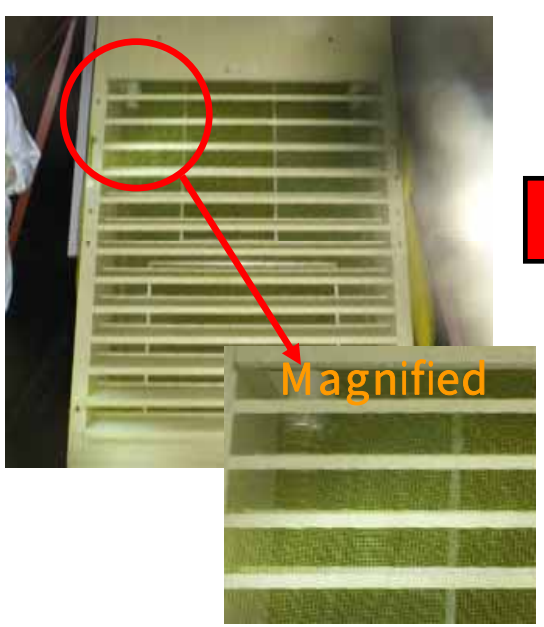
◎Confirmed the alarm indication "compressor trouble" at the PSA main monitor.

◎Confirmed "Drier trouble" at the alarm display of the compressor itself.

<<Countermeasure>>

◎Removed the net which had been set in front of the inlet filter of the compressor.

We confirmed that rain water adhered to the net which had been set to prevent matters including insects from absorbing. Because water rain was suspected as the cause, we removed the net, rebooting the compressor, and confirming normal operation.



3 Future measures and operational change

<<Treatment responding to the investigation result of cooling fan inverter of PSA Unit 4>>

Regarding the inverter for the cooling fan, if any additional countermeasures are found to be necessary based on the investigation at the factor, we will reflect it to implement.

<<Operational change of PSA Unit 3 and 4>>

Currently, PSA Unit 3 and 4 are in switching-mode operation, working in turn.

We will continue to improve to avoid PSA to trip. For the aim to avoid the possibility the case when nitrogen supply would stop, as much as possible, both PSA Unit 3 and 4 will be operated as regular for a while after the replacement of cooling fan inverter of PSA Unit 4. Nitrogen will be supplied to each plant with such status.

4 The status of nitrogen injection recovery in case of nitrogen gas separator (PSA) trouble

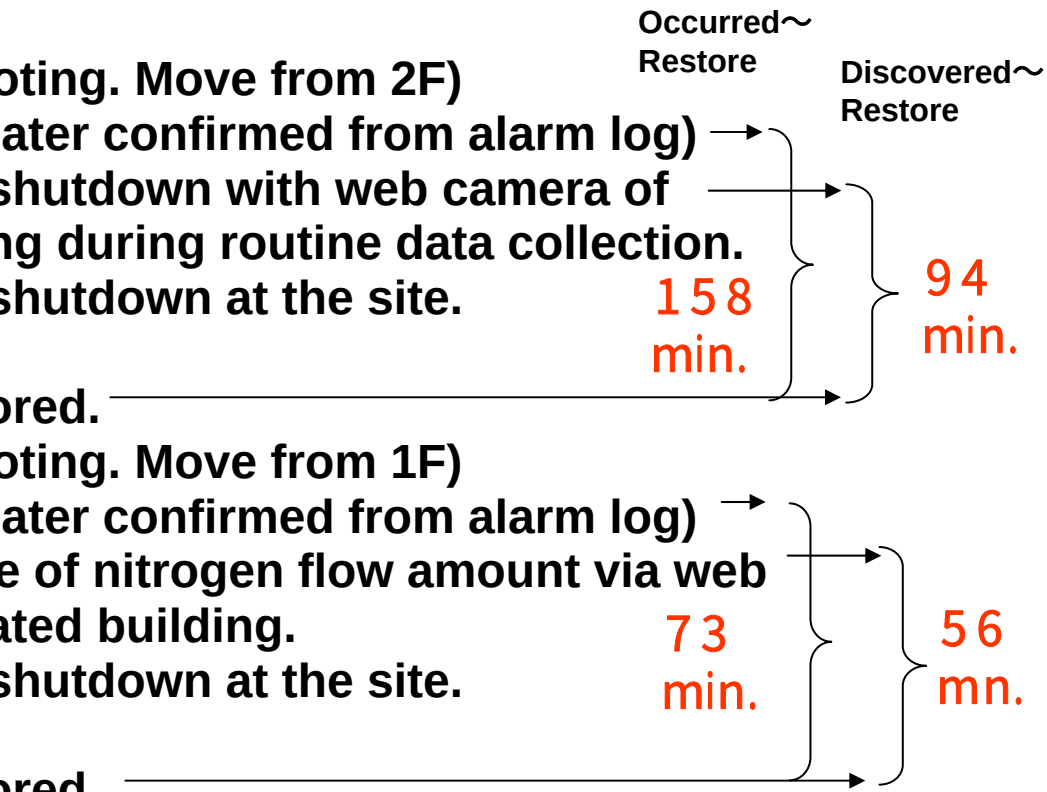
<The trouble description of PSA>

◯4/4 PSA Unit 3 (Treatment for booting. Move from 2F)

- **9:51 PSA Unit 4 shutdown (later confirmed from alarm log)**
- **10:55 Confirmed PSA Unit 3 shutdown with web camera of seismic isolated building during routine data collection.**
- **11:26 Confirmed PSA Unit 3 shutdown at the site.**
- **12:16 Booted PSA Unit 4.**
- **12:29 Nitrogen injection restored.**

◯4/7 PSA Unit 4 (Treatment for booting. Move from 1F)

- **16:43 PSA Unit 4 shutdown (later confirmed from alarm log)**
- **17:00 Confirmed the decrease of nitrogen flow amount via web camera of seismic isolated building.**
- **17:35 Confirmed PSA Unit 4 shutdown at the site.**
- **17:43 Booted PSA Unit 3.**
- **17:56 Nitrogen injection restored.**



It took a maximum about 160 minutes from the PSA's shutdown to nitrogen gas injection restoration.

5 Summary of treatment policy at an early stage during PSA trouble time

Current status

<Frequency of monitoring>

We have checked the nitrogen injection amount once in six hours with web camera of seismic isolation building. If there is a trouble like PSA shutdown, it could take a maximum of six hours to find the status.

<Site check>

It needs approximately 30 minutes if staff move from the seismic isolation building. It would need additionally 60 minutes if staff move from 2F.

<PSA boot/ valve operation>

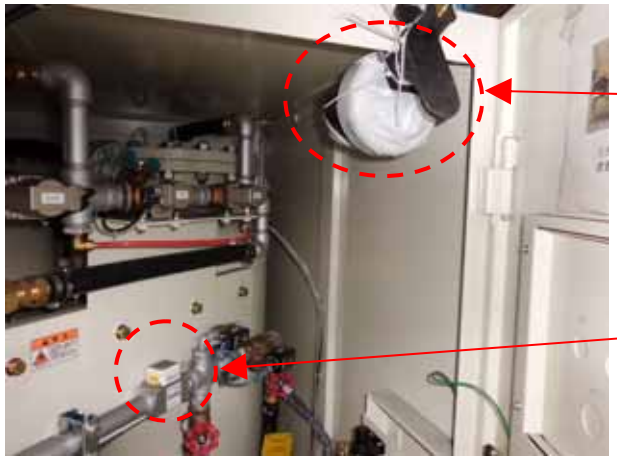
It needs approximately 15 minutes from the valve operation of PSA at the site to nitrogen supply. In addition, it need about 5 minutes for valve operation.

Treatment policy at an early stage during PSA trouble time

- **To install web came so that we can easily check the operation status of PSA from the seismic isolation building (the frequency of monitoring would be once an hour because the check will become easy).**
- **To install an equipment which emit alarm at the seismic isolation building in case of PSA shutdown.**

6 Monitoring using web camera of PSA Unit 3 and 4 at Seismic Isolation Building

- **To check the operation status of PSA Unit 3 and 4 from Seismic Isolation Building, we installed web camera [Implemented on April 10].**
- **The place where the web camera monitors is flow meter of nitrogen emission inside PSA. The amount of the flow becomes zero when PSA stops. Therefore the camera can check the operation/standstill status of PSA.**



PSA Unit 3

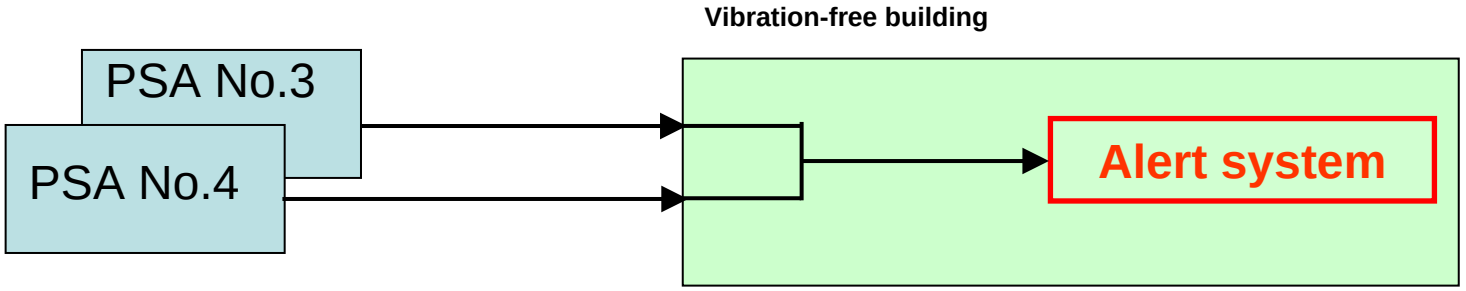
Web Camera

flow meter of nitrogen emission

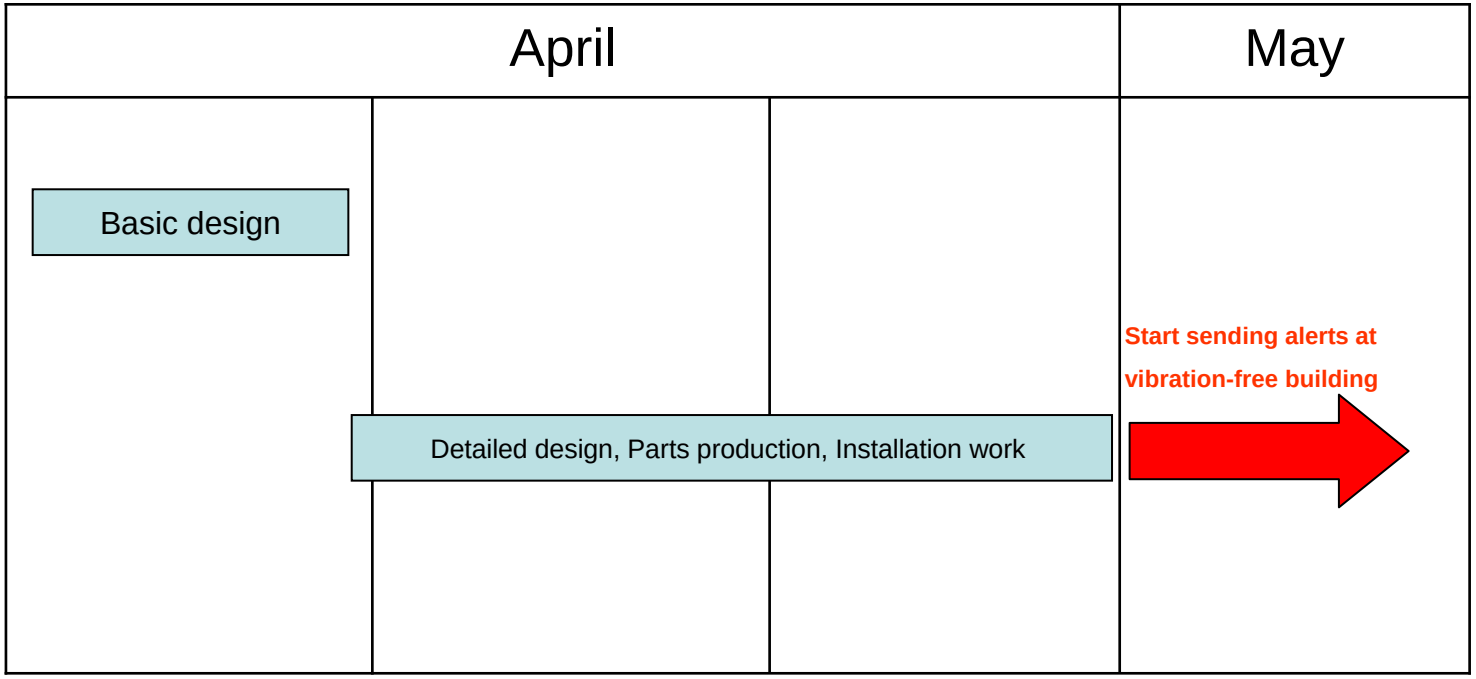
PSA Unit 4

7 Installation of alert system of PAS No.3,4 at vibration-free building

Receive the alert signal from PSA settled on the spot, and send the alert (lump and buzzer) to alert panel (or PC) settled at vibration-free building. In case alert happens on the spot, alert is sent to vibration-free building in a timely manner.

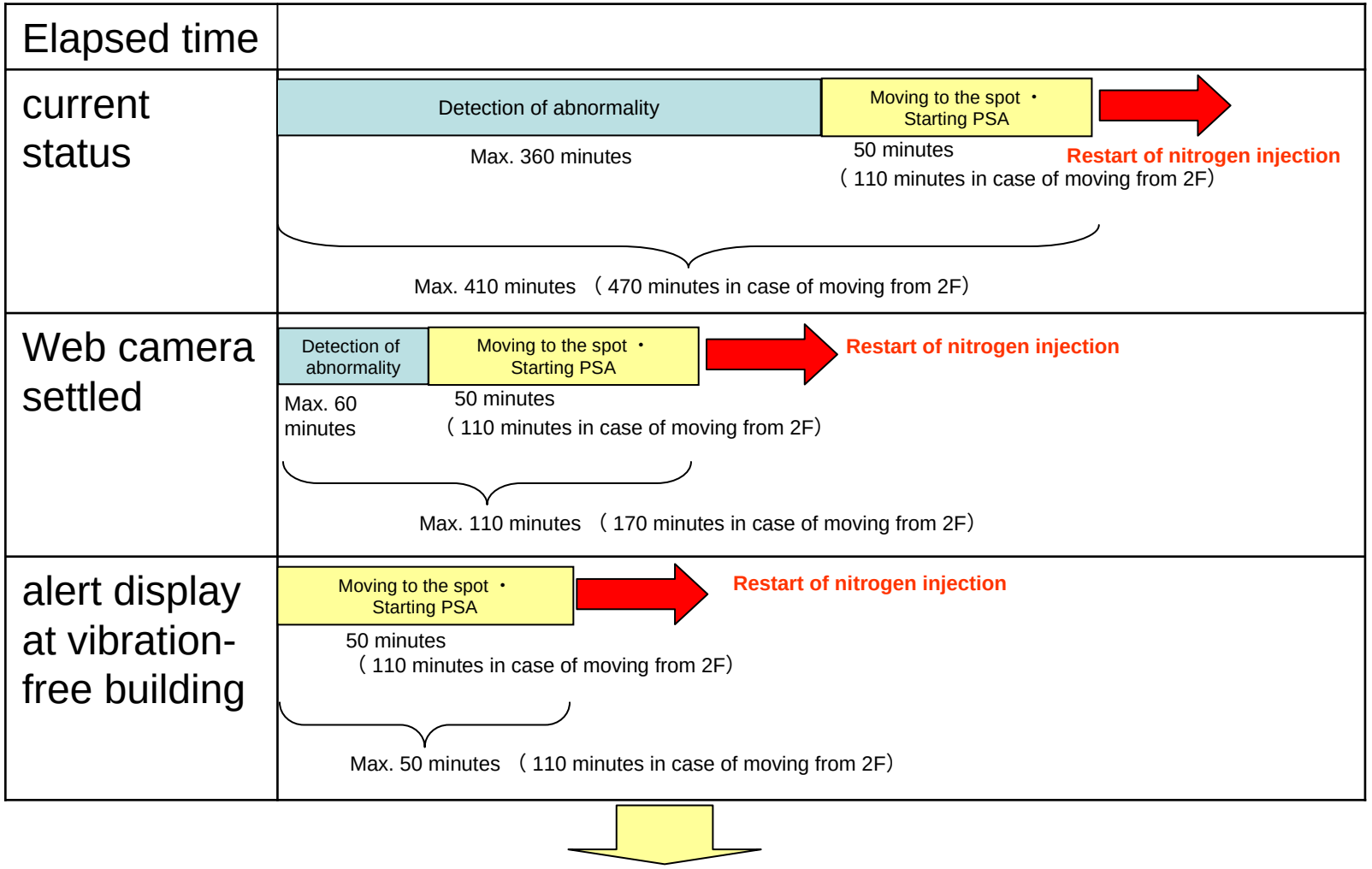


8 Installation schedule of alert system of PAS No.3,4 at vibration-free building



9　Restarting time of nitrogen injection after the implementation of the pro-active measures in PSA trouble

Estimated restarting time of nitrogen injection after the implementation of the pro-active measures in PSA trouble is shown.



Time savings from PSA trouble to restart of nitrogen injection

- **In case of 4/4　158 minutes　→　94 minutes（64 minutes shorten）**
- **In case of 4/7　73 minutes　→　56 minutes（17 minutes shorten ）**