Fukushima Daiichi NPS Unit 3 Reactor Building

Regarding the Incident Where a Jib Mast at the Tip of a Remote-control Large Crane Was Bent Down [Cause and Countermeasures]

<Reference>
September 24, 2013
Tokyo Electric Power Company

The curse of the incident

On September 5, 2013, a jib mast at the tip of a remote-control large 600-ton crane was accidentally bent down while being parked near Unit 3 Reactor Building. On September 10, we laid down the tip jib mast and the main mast on the ground, and conducted an inspection of the crane and an investigation of the cause of this incident.

Possible cause

- The drum lock of a winch to wind up a wire cable used for hoisting the tip jib mast is operated by hydraulic pressure. The joint section (a screw joint) of a hydraulic pressure hose used for that operation became loose, and the drum lock was released.
- As a result, the wire cable became relaxed, and the tip jib mast was gradually bent down. Eventually, a load larger than expected acted on the main mast, and the upper connection of the main mast cracked.

Recurrence prevention measures

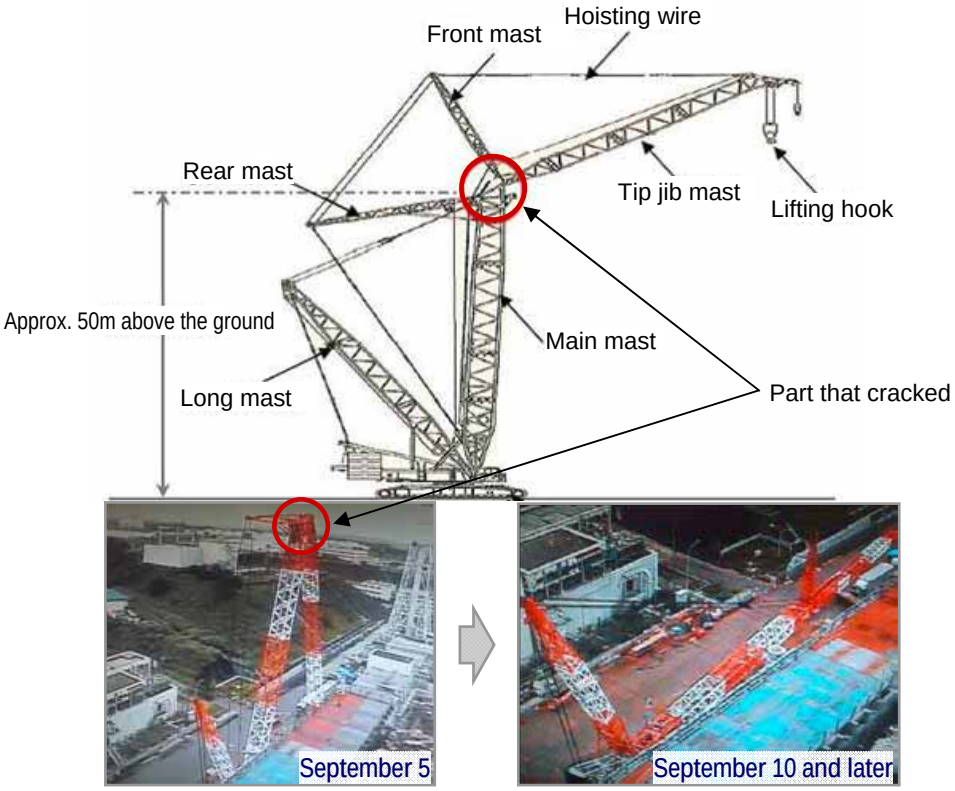
(1) Replacement of the failed screw joint with a new one
(2) Implementation of a procedure that requires a worker to confirm, before and after operating the crane each day, that the screw joint is tight and that the drum lock is in the locking state.
[Added as a monthly and a daily inspection item]
(3) Installation of an indication light by which a worker can see whether the drum lock is in the locking state.

Restart of the operation

On September 24, we explained the cause and countermeasures regarding the bent-down mast to the Labor Standards Supervision Office, and our explanation was accepted. In addition, the Office approved our use of another 600-ton crane.

- We are planning to restart the operation of the failed 600-ton crane as soon as we are ready after replacement of the damaged part and implementation of recurrence prevention measures.
- With regards to a large 750-ton crane in use for construction (currently suspended) of a covering for the Unit 4 Reactor Building, we confirmed that the same incident cannot occur because that crane uses a joint different from the one used in the failed 600-ton crane. Accordingly, we are planning to restart the construction work as soon as we are ready.

Overview of the remote-control large 600-ton crane

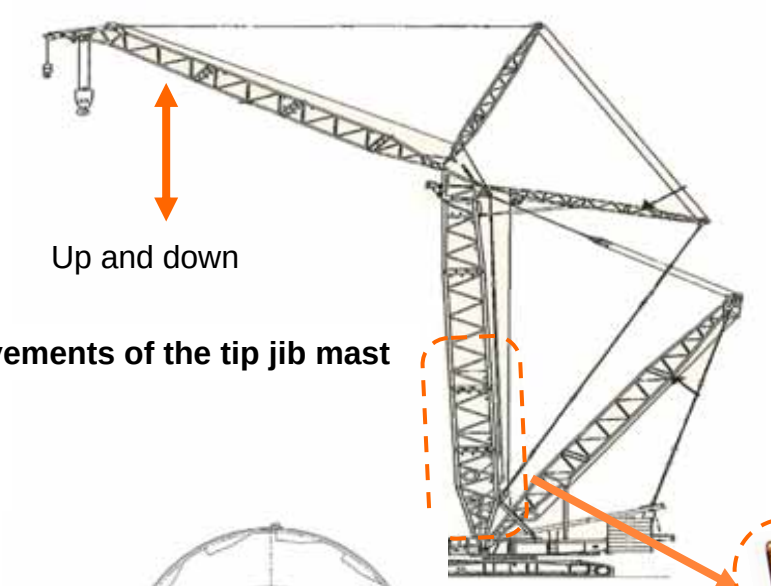


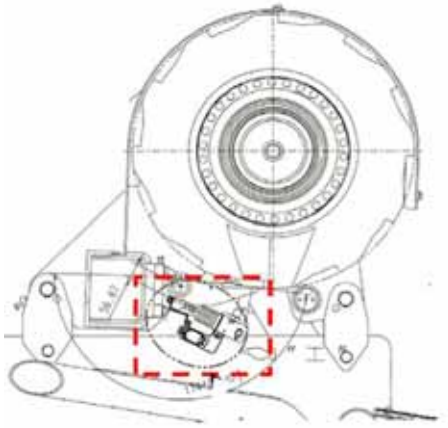
The failed part (a screw joint) and the released state of the lock

◆Mechanism of the failed crane

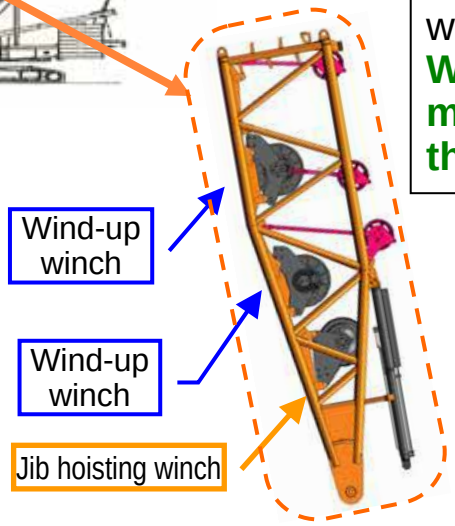
The failed crane has a winch embedded in the boom for size reduction of equipment, and hence has a mechanism different from that of a typical crane.

■ **Overview of the failed crane (600-ton crane: 6000SLX)**





Drum lock (brake mechanism)



■ When the crane is operated

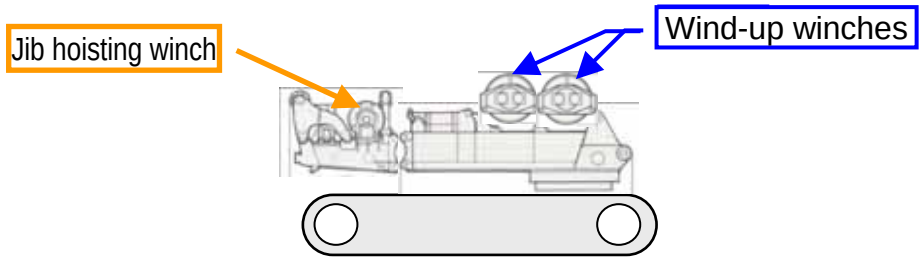
The winch is rotated so that a wire can be wound up and down and stopped. When the wire is thus wound up and down and stopped, the tip jib mast moves up and down and stops.

When the crane is operated, the rotation of the winch is controlled by hydraulic pressure, whereby the tip jib mast never automatically moves down.

■ When the crane is not operated

A brake mechanism (a drum lock) mechanically locks rotation of the winch, and thereby immobilizes the wire, resulting in immobilization of the tip jib mast.

When the crane is not operated, the brake mechanism works to keep the tip jib mast up in the same position and state.



Typically, winches are mounted on the main body of a crane.

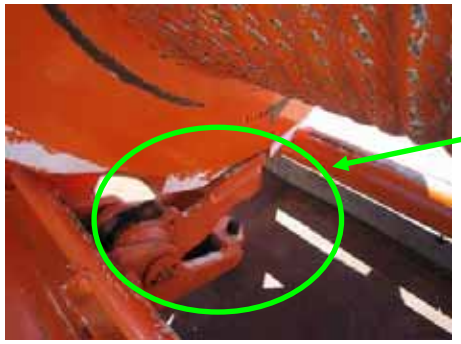
◆Direct cause that triggered this incident

The drum lock* of the jib hoisting winch was released, and this caused the hoisting wire to relax, so that the tip jib mast was gradually bent down. Then, a load larger than expected acted on and caused a crack to the main mast.

[Cause of the release of the drum lock*]

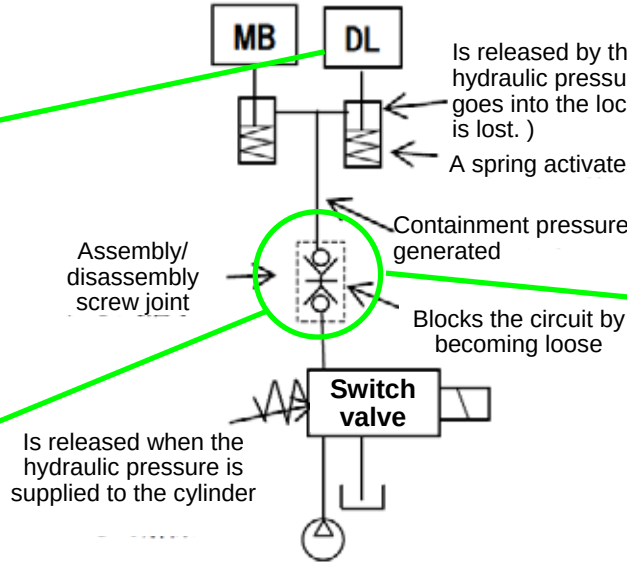
- The drum lock* was released as the loosened assembly/disassembly screw joint, which was in used for the hydraulic hose of the drum lock, prohibited decrease in hydraulic pressure.
- The drum lock normally functions to unlock the winch as a result of increase in hydraulic pressure while the crane is operated, and to lock the winch as a result of decrease in hydraulic pressure while the crane is not operated.

*** Mechanical brake**



Drum lock

The assembly/disassembly screw joint

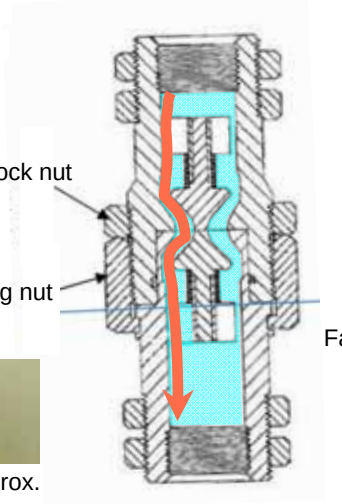


Unlocking line of the drum lock (DL) motor brake (MB)

Mechanism diagram of the drum lock

[Locking by the drum lock]

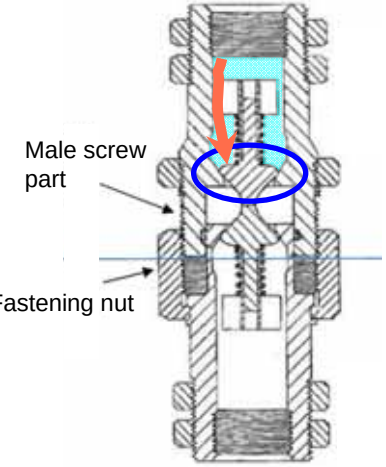
Oil goes back



[When operating properly]

[Unlocking by the drum lock]

Oil was unable to go back blocked by the loosened screw



[When this incident occurred]

Cross-sectional views of the screw joint for assembly and disassembly

◆Fundamental factors that triggered the direct cause

Possible fundamental factors

(1) The assembly/disassembly screw joint might have been defective as an individual product.
(2) The crane might have received larger vibration than when operated under typical conditions to the extent that damage, such as loosening of a nut, was caused to some of the parts.
(3) A third party might have intentionally hit the relevant part.

Analysis to find fundamental factors

With regards to the failed crane, the annual inspection was conducted at the end of June 2013, where the assembly/disassembly screw joint was confirmed to be tight. The incident occurred in about 3 weeks after the inspection.

The joint became loose for the first time since we started to use it about 2 years ago, in July 2011, when it was manufactured. For this reason, it is highly unlikely that the narrowed-down possible fundamental factors (1) and (2) occurred singly.

- ☐ Factor (1)
  Based on what we heard from the manufacturer, the relevant joint section is usually unlikely to become loose, and it is highly unlikely that the screw joint becomes loose solely because the joint is defective as a product.
- ☐ Factor (2)
  Work to create a hole for a garter for an overhead traveling crane, which was conducted after the annual inspection at the end of June, is a type of work that causes more frequent vibration associated with upward and downward motions of the jib than usual. However, the same types of work were conducted before. In addition, only one of the screw joints suddenly became loose while the other screw joints that also suffered vibration did not. For these reasons, it is highly unlikely that this incident occurred due solely to this work.

Incidentally, a 750-ton crane (for Unit 4) does not have a screw nut, and hence the same incident never occurs to that crane (it has had no failure for about 34 years).

◆Recurrence prevention measures

Measure (1)	Replacement of the failed screw joint used in the brake mechanism with a new one	[Factor (1)]
Measure (2)	Addition of a procedure that requires a worker to confirm, before and after operating the crane, that the screw joint is tight and that the drum lock is in the locking state, as a monthly and a daily inspection item.	[Factors (1), (2), and (3)]
Measure (3)	Installation of an indication light by which a worker can see the status of the drum lock from a remote room.	[Factors (1), (2), and (3)]

Note that our supervisors are to check inspection results of the respective inspection items by attending inspections or examining inspection records.

[Specific improvements added to inspections]

Inspection frequency	Section to be inspected	[Failed crane] 600-ton crane (Unit 3)	[Similar crane used for fuel removal] 750-ton crane (Unit4)
Annual inspection	Joint section	• Visual inspection (of oil leakage, damage, and deformation)	• Visual inspection (of oil leakage, damage, and deformation)
	Piping for hydraulic pressure	• Visual inspection (of oil leakage, damage, and deformation)	• Visual inspection (of oil leakage, damage, and deformation)
	Loosening of nuts	• Inspection by percussion with a test hammer	• Not to be inspected because they are not used
	Drum lock	• Functional inspection (of the locking state) • Visual inspection (of abrasion and damage to parts)	• Functional inspection (of the locking state) • Visual inspection (of abrasion and damage to parts)
Monthly inspection	Joint section	• The same as in the annual inspection	• The same as in the annual inspection
	Piping for hydraulic pressure	• The same as in the annual inspection	• The same as in the annual inspection
	Loosening of nuts	(Changed portion) • Addition of “inspection by percussion with a test hammer”	• Not to be inspected because they are not used
	Drum lock	(Changed portion) • Addition of “visual inspection (of abrasion and damage to parts)”	• The same as in the annual inspection
Daily inspection	Joint section	(Changed portion) • Addition of “visual inspection by section (of oil leakage, damage, and deformation)”	• The same as in the annual inspection
	Piping for hydraulic pressure	(Changed portion) • Addition of “visual inspection by section (of oil leakage, damage, and deformation)”	• The same as in the annual inspection
	Loosening of nuts	(Changed portion) • Addition of “inspection by percussion with a test hammer”	• Not to be inspected because they are not used
	Drum lock	(Changed portion) • Addition of “pre- and post-operation functional inspection (of the locking state)” • Installation of indication light enabling workers in remote room to see the locking status	(Changed portion) • Addition of “post-operation functional inspection (of the locking state)”