Inspection Manual for Dam Field Engineers After Seismic Events, Ichari Dam, Uttarakhand

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January, 2018

Prepared by

Japan Water Agency, Japan
under the
Dam Rehabilitation and Improvement Project

Front Cover Photograph: Ichari Dam across the Tons River in Uttarakhand.

Government of India
Central Water Commission
Central Dam Safety Organization

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January 2018

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Government of India
Central Water Commission
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The *Inspection Manual for Dam Field Engineers after Seismic Events, Ichari Dam, Uttarakhand* has been published for the first time in January 2018 under the Dam Rehabilitation and Improvement Project (DRIP)

Disclaimer

The *Inspection Manual for Dam Field Engineers after Seismic Events, Ichari Dam, Uttarakhand* in no way restricts the dam owner in digressing from it. The Central Dam Safety Organization or the Central Water Commission cannot be held responsible for the efficacy and sufficiency of procedures to be adopted after the seismic events. Appropriate discretion may be exercised while preparing and implementing evaluation and reporting mechanism in the case of seismic event.

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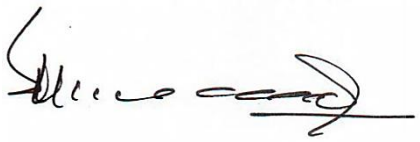
MESSAGE

India has more than 5200 large dams catering to water and power requirements of the country. Considering that most of the dams are designed to withstand the earthquake shocks as per the prevalent standard practices, it becomes of critical importance to ensure that the existing aging dams are safe in changing hydrological and seismic scenarios and continue to operate as designed producing benefits to the society.

Standards, practices and technology change with time and it is expected that dam engineers should be able to enhance the safety of our existing dams. For this purpose, World Bank took a lead for capacity enhancement of dam engineers in India by deputing a team of experts of Japan Water Agency utilizing to Ichari Dam of Uttaranchal Jal Vidyut Nigam Ltd (UJVNL). All the dam safety aspects dealing with post seismic scenario were studied and documented. Engineers of DRIP dams were also trained by holding Mock drills with practical and theoretical exercises. I am sure that this kind of study has been done for the first time in India. The study has been compiled and presented in the form of a Manual.

Every dam is unique. In the interest of dam safety, it is necessary to have operation and maintenance procedures for their functioning for all dams. In the same manner, there is a need to have post seismic event inspection manual for field engineers for each dam. The *Inspection Manual for Dam Field Engineers after Seismic Events has* been published using Ichari Dam as a case history. I sincerely believe that this compilation shall help dam owners in India to make similar manual catering to specific needs of each dam for helping in enhancing the safety of their respective dams. I also urge each dam owner to conduct mock drills for this purpose at regular intervals.



(S Masood Husain)
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Central Water Commission

New Delhi
January 2018

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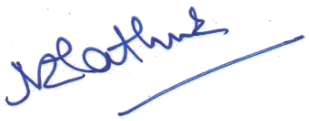
FOREWORD

A dam monitoring and inspection program provides the information that is needed to develop a better understanding of the performance of the dam. Knowing that the dam is performing as expected is reassuring to dam owners and other stakeholders including the general public and the ability to detect a change in this performance is critical for the dam owner who is directly responsible for any consequences. Seismic stability of our dams particularly in the highly seismic areas is of great concern and requires special attention. With operational performance knowledge, dam owners will have the ability to operate and maintain their dams in a safe manner through early identification and modification/ management/rectification.

The present *Inspection Manual for Dam Field Engineers after Seismic Events, Ichari Dam, Uttarakhand* describes all elements of inspection and monitoring of existing dam after the occurrence of a seismic event. The various checklists required for discovering deficiencies if any after the occurrence of a seismic event have been explained in this manual. Instruments like seismographs and accelerographs required for measuring the seismic forces and the response of dams have also been explained in this manual. The manual details the best practices followed in Japan and elsewhere with the case history of Ichari dam in Uttarakhand described in detail.

I hope that this manual will be quite useful to dam engineers for planning the comprehensive inspection programme including various checklists required for ensuring the safety of their respective existing dams. I compliment World Bank especially Mr. Jun Matsmuto, past Task Team Leader as well as Dr. C Rajgopal Singh, present Task Team Leader, DRIP, Japan Water Agency, Uttaranchal Jal Vidyut Nigam, Dam Rehabilitation and Improvement Project, Central Water Commission and all the individuals and organizations who have contributed towards the development of this Manual



(N K Mathur)
Member (Design & Research)
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New Delhi
January 2018

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Abbreviations

CWC	Central Water Commission
DDMA	District Disaster Management Authority
DRIP	Dam Rehabilitation and Improvement Project
EAP	Emergency Action Plan
IMD	Indian Meteorological Department
JWA	Japan Water Agency
MoWR, RD&GR	Ministry of Water Resources, River Development & Ganga Rejuvenation
UJVN Ltd.	*Uttarakhand Jal Vidyut Nigam* Limited

1. Introduction

1.1 Dams in India

India ranks third in the world after China and the United States in terms of number of dams. The dams have been playing a key role in fostering rapid and sustained agricultural and rural development. There are more than 4,800 completed large scale dams with a total storage of 253 billion cubic meters in India.[1] Most of these dams are operated and maintained by the state governments. A few public organizations also own and operate large dams and there are tens of thousands of medium and small scale dams owned by various agencies.

Many large dams are ageing and have various structural deficiencies as well as shortcomings in operation and monitoring facilities. As most of those large dams are highly hazardous, dam safety assurance is necessary to reduce risks and help assurance of sustainability and full operational capacity of existing storage through early identification and rectification of problems.

1.2 Dam Rehabilitation and Improvement Project

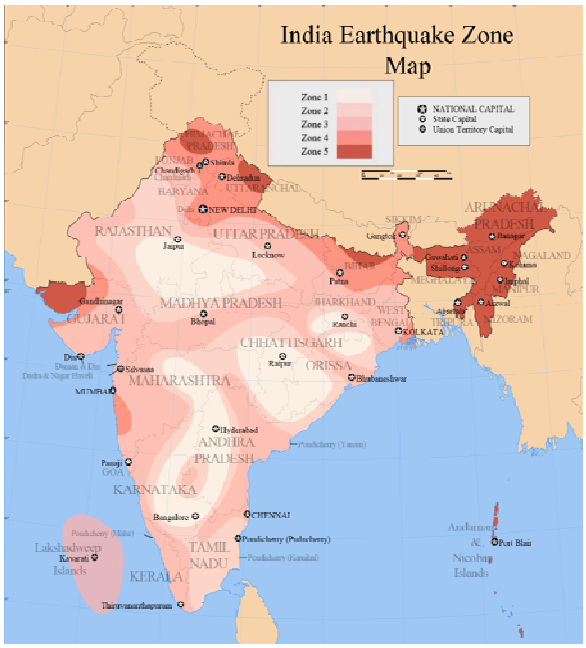
Given above mentioned background on large scale dams in India, Dam Rehabilitation and Improvement Project (hereafter DRIP) has been implemented since 2010 by the Government of India with financial assistance from the World Bank. The objective of the project is to improve the safety and operational performance of selected existing dams in the territory of 6 participating states including Kerala, Tamil Nadu, Madhya Pradesh, Odisha, Karnataka and Uttrakhand and Damodar Valley Corporation, which are deemed as pilot project sites among large number of dams in the country.

The project activities focus not only on the rehabilitation and improvement of dam structures but also address shortcomings in maintenance and provide recommendations for improvements in operation of the dams. This will help keep dams and people in downstream areas safe and secured.

[1] CWC presentation in JWA headquarters in Jan 2015

1.3 An Historical Earthquake in India

The Ministry of Earth Sciences, the Government of India is the official agency for publishing the seismic hazard maps and codes. Figure 1 shows the areal category regarding Earthquake Zones in Indian subcontinent. Zoning is defined based on the historical data values of maximum MM intensities recorded in various parts of the country in the past.



CC-by-sa PlaneMad/Wikimedia https://en.wikipedia.org/wiki/Earthquake_zones_of_India#/media/File:India_earthquake_zone_map_en.svg

Figure 1 Earthquake Zone Map of India

Geographical statistics of India show that almost 54% of the land is vulnerable to earthquakes. North and North East India, both of which are classified zone 4 or zone 5, are especially vulnerable for earthquakes.

In 2015, Gorkha Earthquake centered in Nepal caused the severe damage in Nepal and India. More than 8,800 people were killed in Nepal, and more than 70 people in India. Fortunately no serious damage to dams in India was reported. However, this earthquake raised awareness of the need for field engineers working at dam operation offices to respond systematically in order to secure the safety of dams.

India has a long history of dam construction to manage limited water resources. The demand for water resources is still steadily increasing with the economic growth of India. As of the end of 2010, 4,800 large dams had been constructed. Among them, half of the dams are more than 25 years old and the number of old dams is on the rise year by year. Regarding the dam Safety, the necessity of appropriate responses for the inspection of dams after an earthquake became extremely important with the increase of those old dams.

1.4 Japan Water Agency

Japan Water Agency (hereafter JWA) is legally mandated to develop and manage water resources in seven major river basins in Japan. Up to 2015, JWA completed 30 dam construction projects including water resources development in natural lakes and approx. 5,500km irrigation channel construction and rehabilitation projects. All of the dams and related facilities completed under the above projects are now also operated and maintained by JWA.

As a managing organization of large scale hydraulic structures, JWA has been tackling earthquake countermeasures together with the other types of disasters from planning and designing stage till operation and maintenance stage. Earthquakes are very frequent in Japan. If any infrastructure is severely damaged by an earthquake, it would immediately affect people's lives and economy, and the restoration from the disaster would take a long time. In order to minimize such impacts, JWA established disaster prevention plans, checklists and manuals for daily operation, and has been periodically organizing drills with relevant organizations such as national government and local municipalities.

1.5 Regulatory Frameworks for Dam Safety in Japan

Following shows a history of development of regulatory frameworks on dam safety focusing particularly on earthquake-proof in Japan.

i) History of earthquake-proof design and assessment on dams in Japan

The oldest existing dam in Japan is the Sayama-lke, earth fill dam, which was initially constructed in the early seventh century. After that, renovation and rising were made several times during 1400 years up to now. The Sayama-Ike is still functional for water supply and the flood control. When the major renovation was made in 1999, the detailed investigation of dam body was conducted. It was found that there were clear marks of damages by the significant earthquakes in the year of 734 and 1596 inside the dam body.

In 1925, Dr. Nagaho Mononobe, Japanese prominent civil engineer, proposed the first theory of earthquake-proof dam design titled "seismic coefficient method" in the world. After that, a lot of large dams in Japan were designed and constructed based on his theory. Dr. Mononobe also established world epoch theory regarding infiltration and shear forth of earth-fill dams, and made a great mark on enhancement of dam engineering and dam safety in Japan. Dams in Japan designed

based on the seismic coefficient method" showed high seismic resistances even when the 1995 Kobe earthquake and the other significant earthquakes hit.

Regarding the seismic design, "Ministerial Order under Cabinet Order concerning Structural Standards for River Management Facilities, etc" defined to divide the three kinds of earthquake zone "strong earthquake zone" "medium earthquake zone" and "weak earthquake zone", and defined the earthquake intensity for dam design for each zones

Additionally, every dam in Japan is recently in trial for the safety assessment against probable maximum large-scale earthquakes of each site. The technical guideline for this assessment titled "the draft guideline for the verification of dam seismic performance against large-scale earthquake" was launched by Ministry of Land, Infrastructure, Transport and Tourism in 2005.

ii) History of dam safety control in Japan

In 1957, Japan Commission on Large Dams (JCOLD) compiled "the standard of dam design". This was a technical standard based on the united dam design philosophy in consideration with existing Japanese dam technologies and new one imported from USA and other countries, and became a basis for design of dams in Japan.

In 1964, the structural criteria on dam engineering were legally authorized by revising the river law. JCOLD also issued "the standard for monitoring structure of completed dams" in 1973. Following these actions, "the cabinet order concerning structural standards for river management facilities" was enacted in 1976, and current regulatory framework for dam safety was established.

These standards define that measurement items for the dam safety should be amount of water seepage, deformation of dam bodies, uplift pressure under basement of concrete dams, and surface line of seepage for homogeneous earth fill dams. In addition, further specific measurement items and standard interval of measuring them are defined for every structural type of dams, height of dam and stage of dam safety management after storing water firstly.

Seismic movements of dam body have been measured at lots of existing dams as before. In 2014, the technical standard for river and erosion control engineering

requires to keep the seismic records of dams and their foundations as well as data of water seepage, uplift, deformation and surface line of seepage. The above items are requisite minimum for monitoring the dam safety

In addition to those, stress gauges, strain gauges, thermometers and others are installed in a dam body or its foundation for assessing a dam's behavior and its safety according to conditions and requirements of individual dams.

iii) Check and survey for dam safety monitoring

Monitoring system for dam safety consists of 1) daily patrol and check, 2) emergency check, 3) regular inspection, and 4) comprehensive inspection.

Daily patrol and check is conducted by field officials at each dam with visually checking and reading above mentioned data. Emergency check is also carried out by field officials immediate after a large scale earthquake and other significant disasters. The timing of emergency check such as quick check, first inspection, secondary detailed inspection and respective report after an earthquake is strictly defined by the ministerial order. Regular inspection shall be done in every three year by an expert team at a target dam. The comprehensive inspection is a new scheme for aged infrastructures (over 30 years old dams), which is also carried out by an expert team with supervision of academia. According to the result of comprehensive inspection, the field officials develop a long life plan for the dam structure. Following this plan, monitoring system is reviewed and rehabilitation is carried out.

1.6 Case study on earthquake correspondence in Japan

Japan is a country with frequent earthquakes. Regarding earthquake correspondence, some case study of Japan and JWA as a dam manager is attached in Appendix 1.

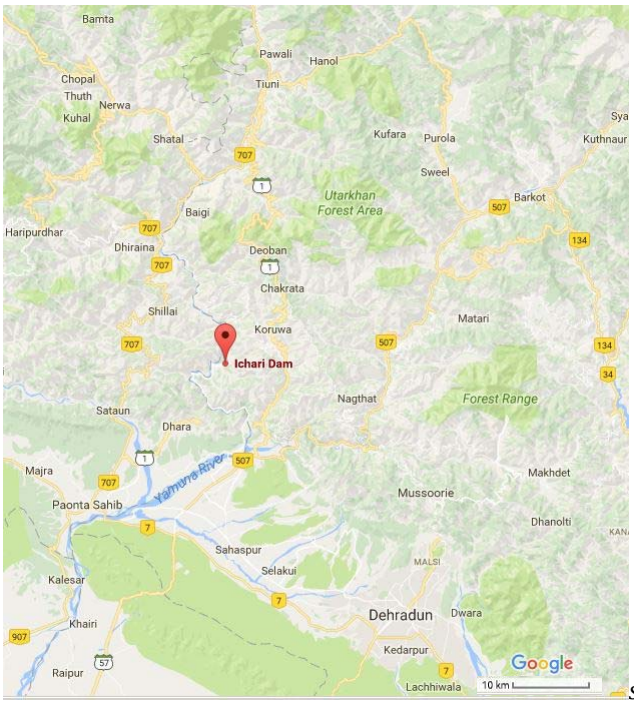
2. Scope of Work

2.1 Objective

The consultancy service aims at reviewing the operations and maintenance methods, procedures and status of dams under DRIP, and providing advice and guidance to improve operation and maintenance methods with specific focus on safety of the dam after a seismic event. It is envisaged that a DRIP dam, on mutual agreement between CWC, World Bank and JWA, will be selected as pilot project where detailed investigation will be carried out. At the end of the consultancy, checklists and manuals including standard operating procedure for field engineers will be developed.

2.2 Project Site

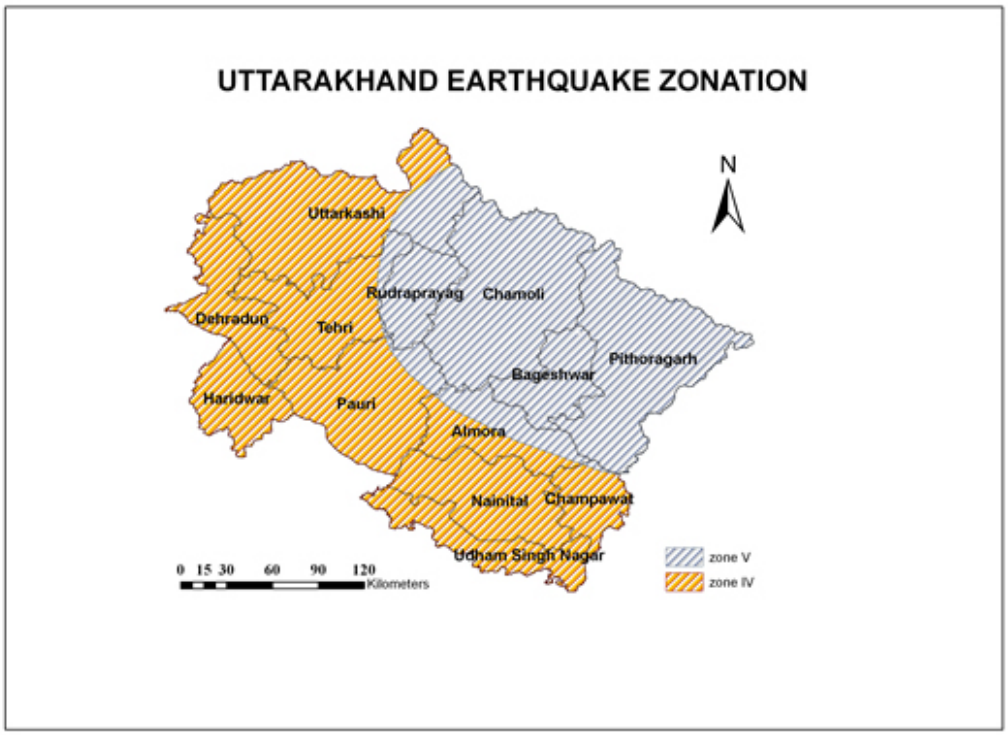
Following the recommendations from CWC, Ichari Dam located in Uttarakand State was selected for the project site. Up to date, CWC, World Bank and JWA have conducted several exposure visits in Japan. Also JWA visited CWC and their project site for technical consultation. During these personal exchanges, project site selection was discussed and proposed by CWC, taking into account applicability and eligibility for the first attempt of earthquake emergency response and also linkage with DRIP.



source: Google Map

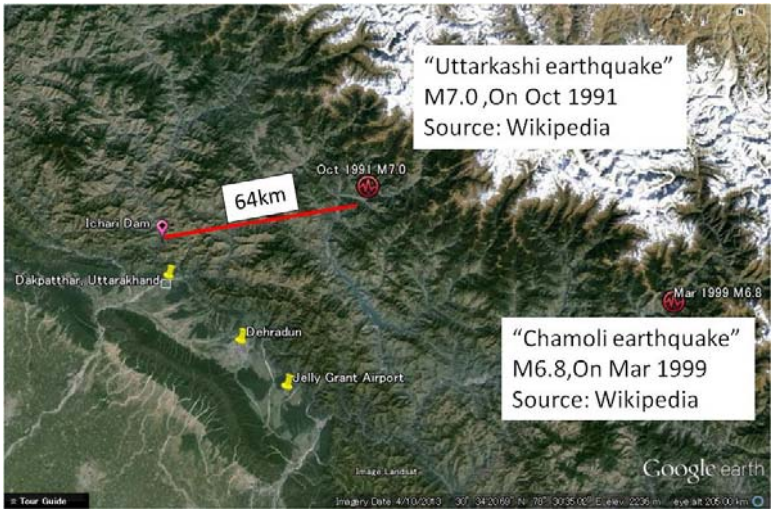
Figure 2 Location of Ichari Dam

Ichari Dam is a concrete gravity dam with the height of 59m, and is owned by *Uttarakahand Jal Vidyut Nigam* Ltd, (hereinafter "UJVN Ltd."). This dam is located on the upper Tons River and 70km far from Dehradum. The altitude of the dam crest is EL.652.00m, while the foundation level is EL.592.75m. The Ichari Dam was selected as the target dam for this consultancy service since the dam is located in high-frequency earthquake potential area categorized in zone 4 and is equipped with seismometers for monitoring. Figure 4 shows the recent severe earthquakes occurred near Ichari Dam. The epicenter of "Uttarkashi earthquake" was only *64km* away from Ichari Dam. Fortunately, no disaster caused by the earthquake was reported, however it is obvious that Ichari Dam is under the high risk of a severe earthquake.



source: National Institute of Disaster Management

Figure 3 Uttarakhand Earthquake Zone Map



source: Google earth

Figure 4 Location of Recent Severe Earthquakes

2.3 Approach and Methodology

i) A field survey and a consultation meeting at the target dam

Firstly, JWA team visited the project site and learned the technical features of the target Dam, i.e. Ichari Dam. Then, the consultation meeting with field engineers was held to introduce earthquake emergency response scheme of JWA.

Field engineers from other dams and responsible officials from UJVN Ltd. and/or CWC joined this meeting.

ii) The draft of earthquake emergency inspection manual & checklist

In accordance with the briefing by JWA regarding the guidelines, JWA team will show the procedures to draft emergency inspection checklists and manuals. The participating field engineers will develop draft emergency inspection checklists and manuals for the Ichari Dam through the group discussions.

Figure 5 shows an example of the checklists for an after-seismic event. JWA prepared different checklist for each facilities. The participants are supposed to modify and organize the tailored checklists for their individual operating dams.

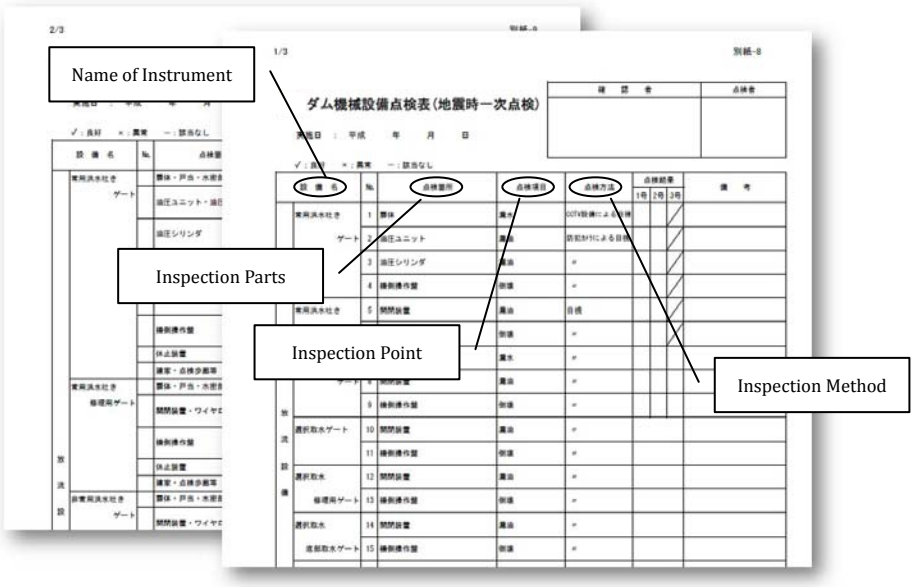


Figure 5 An Example of Checklist for an After-seismic Event in Japan

iii) A field drill and the revision of manual & checklists

The field drill for the emergency response against an earthquake scenario will be conducted at the target dam two months after the consultation meeting. The drill will facilitate the adaptation of the draft checklists and manuals, and help further improvement of them.

JWA team will continuously support the drafting work before the field drill and developing the drill scenario.

2.4 Concept of Earthquake Emergency Inspection

The checklists and manuals will be developed based on the JWA's practices and discussions with CWC, UJVNL and relevant persons/organizations. In the case of JWA, earthquake disaster management is graded in accordance with observed seismic intensity or acceleration at the facilities and specific inspections to be conducted after significant shock are regulated in chronological order (see Figure 6). The checklists for each inspection are prepared respectively and immediately reported to higher authority.

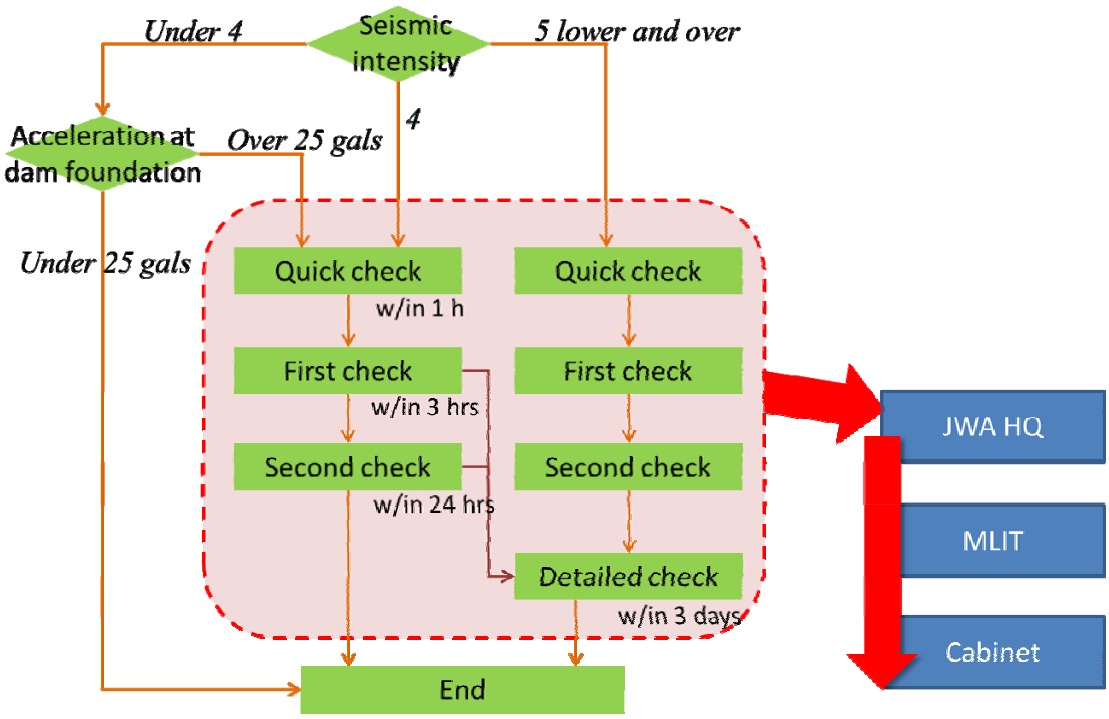


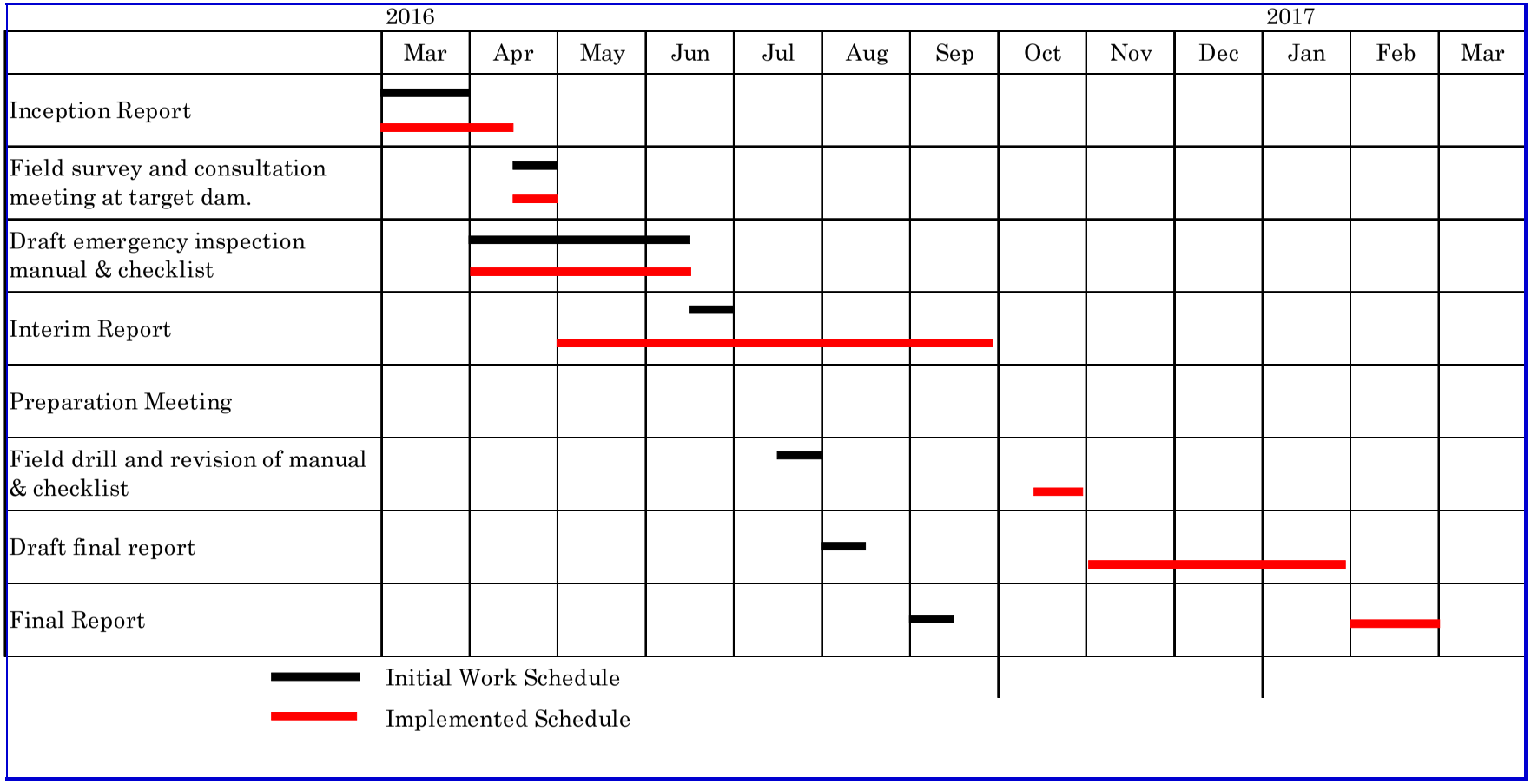
Figure 6 Outline of JWA Earthquake Disaster Management

3. Work Plan

3.1 Timeframe

Based on the discussion with the World Bank and counterpart agencies in India, the work schedule was revises as the next page. It was advised by CWC and UJVNL to avoid flood season for the field drill, and JWA agreed to plan it in the end of October.

Work Schedule



3.2 Team Composition

Table 1 Member of Implementation Team

Kentaro Kido	Team Leader & Chief Technical Advisor
Tatsuo Kunieda	Deputy Team Leader & Dam Operation Expert
Masahiro Sugiura	Dam Operation Equipment Expert
Nobuyuki Ichihara	Dam Safety Expert
Tadashige Kawasaki	Law and Institution Expert

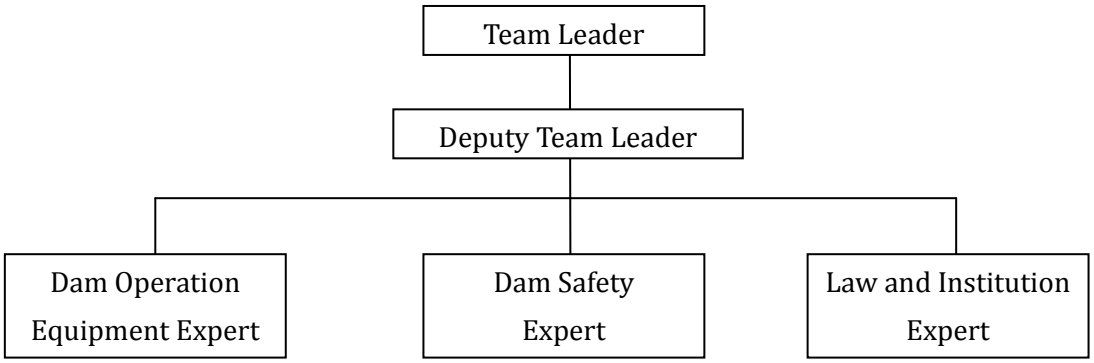


Figure 7 Organization of the implementation team

4. Counterpart Agencies

4.1 World Bank

The World Bank provided proactive support for the implementation of the services for the enhancement of the capability of the field engineers for operation and maintenance of dams.

4.2 Central Water Commission, Ministry of Water Resources River Development & Ganga Rejuvenation

CWC is a premier technical organization in the field of water resources, closely working with Ministry of Water Resources, River Development & Ganga Rejuvenation (hereafter -MoWR, RD&GR) and Government of India. The commission is entrusted with the general responsibilities of initiating, coordinating and furthering schemes for control, conservation and utilization of water resources throughout the country in consultation with state governments concerned for the purpose of flood control, irrigation, navigation, drinking water supply and hydropower development.

Since 2010, CWC has been taking a leadership of the management of DRIP. The target dam candidates were selected from the dams of DRIP as the result of discussions among DRIP members. For these services, CWC will collaborate with the JWA to apply the result of this consultation service for other dams in DRIP.

4.3 UJVN Ltd.

UJVN ltd. was formed to manage hydropower generation at existing power stations and also development and promotions of new hydro projects. UJVN Ltd. is a corporation wholly owned by the State Government of Uttarakhand.

UJVN Ltd. and CWC discussed and finally selected the target dam. UJVN Ltd. closely worked with JWA for implementation of the services. UJVN Ltd. thoughtfully selected participants for the consultation meeting from their field engineers. UJVN Ltd. will also consider the application of the checklists and manuals to other UJVN Ltd.'s dams.

5. The First Consultation Meeting at Ichari Dam

5.1 Objective

One of the main objectives of the first mission is to prepare the checklists and the manual for appropriate action after a seismic event happens.

It is effective and desirable for the engineers of UJVN Ltd. to develop these checklists and the manuals for Ichari Dam by themselves from the capacity enhancement perspective. Accordingly, it is quite important to accumulate the knowledge and skills of developing necessary checklists and manual among the engineers of UJVN Ltd. for future applications in India.

Therefore, JWA team planned the consultation meeting to start from showing the case in Japan why the checklists and manual need to be developed and how they are used in Japan. Then, concrete examples and recommendations for the manual and checklists preparation were presented.

5.2 Mission Itinerary

The mission itinerary is shown on Table 2. The aiming result of the consultation meeting and the findings of field survey were reported by JWA and tentative plan of future activities

was confirmed.

Table 2 Mission Itinerary

Date		Itinerary	Remarks
17 Apr	S	17:50 Depart from Tokyo (Narita) for Delhi by NH827	
18	M	00:05 Arrive at Delhi by NH0827 10:00 Brief meeting with the officials of CWC at CWC office 16:55 Depart from Delhi to Dehradun by 9W2825 (Jolly Grant Airport)	Stay in Delhi Stay in Dehradun
19	T	10:00-11:00 Brief meeting with the officials of Ichari Dam 11:00-16:00 Field survey of the equipment of the operation office	 Stay in Dehradun
20	W	10:30-16:30 1st day of Consultation meeting at Ichari Dam	Stay in Dehradun
21	T	10:00-16:30 2nd day of Consultation meeting at Ichari Dam	Stay in Dehradun
22	F	9:30-12:00 3rd day of Consultation meeting at the head office of UJVN Ltd. 18:30-19:35 Depart from Dehradun for Delhi (9W2826)	
23	S	1:25 Depart from Delhi for Tokyo (Narita) (NH0828) 13:00 Arrive at Tokyo(Narita)	

The agenda of the consultation meeting is attached in Appendix 2. 27 staff members from UJVN Ltd. and 3 team members of JWA participated in this four day meeting. Participant list is shown in Appendix 3.

5.3 Overview of JWA Team Activities

5.3.1 Field survey on Ichari Dam

The outline of the Ichari Dam is as follows:

Photo 1 Ichari Dam

Table 3 Salient Features of Ichari Dam

Type of scheme	Run-of-river with pond age for daily peak operation
Catchment	4,890 km^2
Active storage	5.11 million m^3
Dam type	Concrete gravity, 59m high
Spillway	Gated, 7 nos. radial gates
Design flood	13,500 m^3/s
Intake	Lateral intake, 4 nos. wheel gates 5.635 x 4.00 m each
Headrace tunnel	diameter 7.00 m, length 6,220 m
Design discharge	Continuous discharge 225 m^3/s, max and short time 235 m^3/s
Spillway gates	Height 16.5 m, lifting speed 300 mm per minute
Other facilities	De-silting chamber, flushing conduit, spillway gantry crane, dewatering pumps, intake trash racks

JWA team started their activities with a field survey of Ichari Dam. After introduction of Ichari Dam, JWA team had a site survey by checking through the crest of dam and the inspection Gallery.

In the inspection gallery, minor leakage from a drain hole was observed. The drainage pumping system installed at the bottom of inspection gallery looked functional.

Most of the staff members live in one community named *Koti* located 2km downstream of Ichari Dam. 20 staff members are working on a three shift basis. Regularly, 5 or 6 officials are working in the office.


Photo 2 Field Survey on 19th April

5.3.2 The consultation and briefing on Checklist, Manual and Field training on after seismic event

The Consultation Meeting was started at the O & M office next to Ichari Dam. The meeting started with the remark from Mr. S. N. Verma, Managing Director, UJVN Ltd. and Mr. B C K Mishra, Director of Operations, UJVN Ltd.

After these remarks JWA team started the presentations from introduction of the organization and responsibility. Subsequently, they move the topic of "Disaster Management of JWA", "Dam Safety for civil engineer, mechanical engineer and electric and telecommunication", "Introduction of Checklist and Manual" and "The field drill for the after seismic event".

In these presentations, JWA team described the legal framework of disaster management in Japan and the response of the field engineer after big earthquake. They focused on the importance of countermeasure activity against seismic event in India.

JWA team explained the concept of manuals which JWA engineer produced considering the risk of the absence of the professional engineer in the case of seismic event, and explained

the tentative schedule of implementation. Participants requested JWA team to move the timing the field drill after monsoon period.

5.3.3 The Discussion with Indian engineer

JWA had a discussion with engineers of UJVN Ltd. to draw a information flow chart in case of a seismic event at Ichari Dam. JWA also conducted group discussions to draft checklists. Engineers are grouped into the civil engineering group, the mechanical engineering group and the electric and telecommunication group.

Through the discussion regarding the information flow, 25 gals at the bottom of Dam is defined as the value which requires the action for the aftermath of earthquake. And only quick inspection and first inspection are prepared in this consulting service, because the second inspection is the same as normal daily inspection.

Photo 3 1st Day of the Consultation Meeting on 20th April

JWA team provided the template of the model dam to show the procedures of drafting the checklists. Using templates, each group drafted the initial checklists of the Ichari Dam, and conducted a field survey to revise the checklists.

Photo 4 2nd Day of the Consultation Meeting on 21st April

5.3.4 Feedback from UJVN Ltd. head office

To review the activities at Ichari dam, JWA team held the meeting at headquarters of UJVN Ltd. in Deharadun. Dr. Umakant Panwar, Principal Secretary of Department of Energy, attended and gave his remarks as the start of meeting.

JWA team summarized their activities and reported outcomes of the consultation meeting on 20 and 21 April. Field engineers of UJVN Ltd. gave their presentation to show the checklists with their impression. After presentation, JWA team explained their plan of next visit for field drill for the response of earthquake.

Dr. Umakant Panwar recommended that they should conduct the field drill with measuring the required time for transferring information from the dam site to the headquarters and to the Disaster Management Center of Central Government. He also mentioned that the dam safety was important for the state of Uttarakhand since it was located in the seismic zone 4 and 5 and vulnerable for earthquakes. He requested JWA team to hold a workshop for dam engineers of UJVN Ltd. at their next visit.

Photo 5 Final Day of the Consultation Meeting on 22nd April

6. Process for Ichari Dam emergency inspection

6.1 Background and Objective

A dam with massive stored water is one of the caution needed structures when a significant earthquake has occurred. Avoiding or minimizing any human and economic damages in lower reach is a race against time. In order to collect and disseminate necessary information about damage to the dam immediately and appropriately and make a decision for subsequent actions, it is essential to establish some scheme to work systematically.

In Japan, it is an obligatory process for the field engineers working at a dam operation office to be automatically assembled for carrying out a prompt dam safety inspection immediate after a significant earthquake event. The inspection results must be reported to the national government on a timely basis. The inspection consists of three phases namely the quick check, the first inspection and the second inspection.

JWA developed and repeatedly upgraded its original manuals of these inspections in order to conduct the inspections without omission even by an inexperienced engineer. Using this experience, the Ichari dam managed by UJVN Ltd. in India was selected to be a pilot site to install this dam emergency inspection system after a quake in India.

In the consultation meeting mentioned in the previous chapter, JWA team presented the process of the emergency inspection aftermath of an earthquake, and the information flow

and the draft check lists are established with participants of the meeting. In the following section, the concept and background of these checklists and manuals are described.

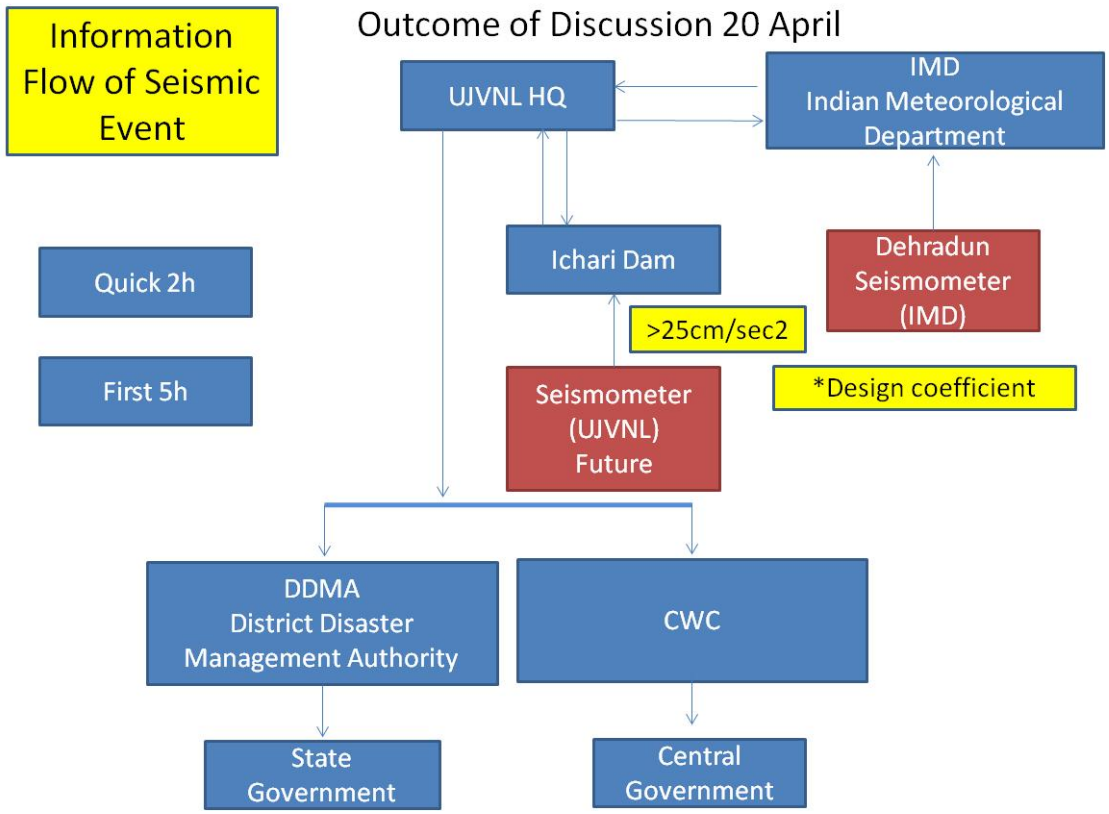


Figure 8 Information Flow for Earthquake Correspondence in the case of Ichari Dam

6.2 Concept

The trigger for starting the sequence of earthquake correspondence is tentatively defined following two indicators regarding the seismic issue. The first one is 25 gals of acceleration observed at the bottom of dam. However, there is no seismometer at the Ichari Dam currently. The second one is the information from IMD. If the epicenter is less than 100 km from the Ichari Dam and estimated magnitude is over 6.0, earthquake correspondence shall be immediately started.

It should be noted that the point for dam safety is seismic intensity at (or very near) dam site. Actually, the second trigger does not directly represent this point and takes some time before starting the quick check. In this context, it is expected that the above

mentioned trigger will be reviewed in accordance with earthquake information availability and compilation of experiences.

The overall framework of the emergency inspection is shown in Figure 9. The emergency inspection narrowed down to the quick check and the first inspection as a result of the consultation meeting. The secondary inspection was excluded from the emergency inspection of Ichari Dam since it can be replaced to the normal daily check. The time line of reporting is adjusted in the context of India based on the discussion result of the consultation meeting. The result of quick check shall be reported within 2 hours and the one of the first inspection shall be within 5 hours.

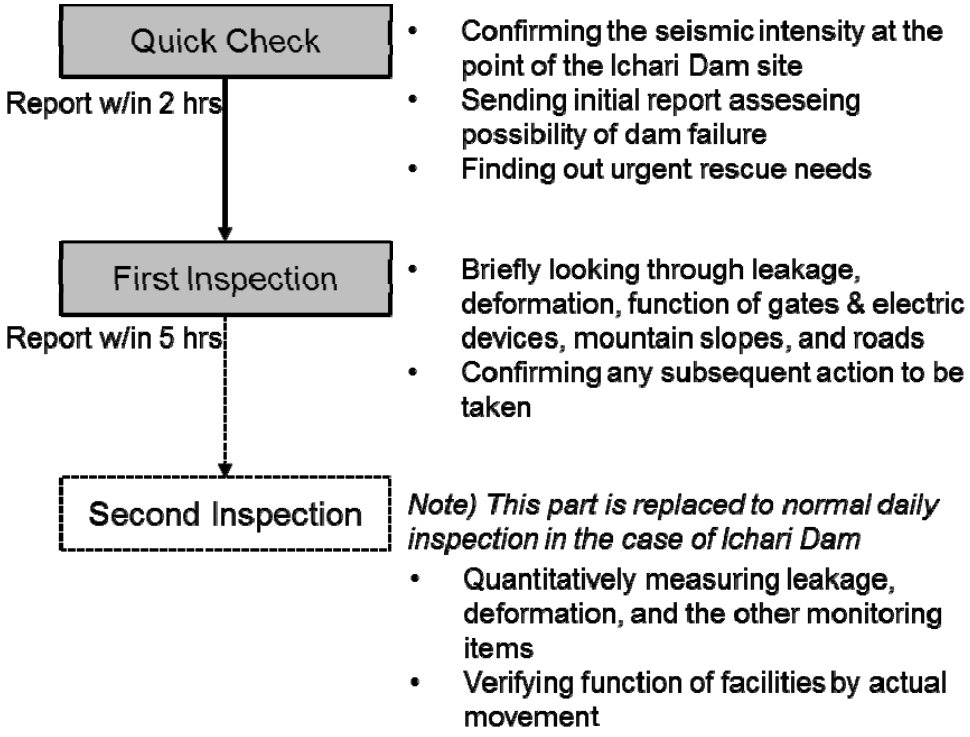


Figure 9 Framework of the emergency inspection of the Ichari Dam

As already mentioned, it is effective to prepare the checklists and relevant manuals for emergency inspection in order to implement lots of checks without any hesitation and redundancy immediate after a significant earthquake. Earthquake drill is also an effective way for all the officials concerned to be accustomed with the checklists and manuals, and to get realistic feedback. By doing this, the capacity of related officials will be enhanced and disaster reaction will become more resilient.

A checklist should contain minimum but sufficient check items. The quick check aims to confirm the received seismic intensity and look through the external figure of dam to assess the possibility of dam failure. The first inspection is to inspect any damages on safety of dam body and its operational function.

One of the common principles in an earthquake emergency situation is no use of elevator. In order to avoid any secondary trouble such as locking some officials in, all the inspections should be carried out without using any elevator. In the case of Ichari Dam, the elevator was removed ten years ago. However, it will be repaired in DRIP.

6.3 Implementation Structure

The inspection aftermath of an earthquake of Ichari Dam, India follows the same principle of Japan. The main information flow comprises various agencies including the CWC of MoWR, RD&GR, the UJVN Ltd. HQ the Ichari Dam and District Disaster Management Authority (DDMA).

The implementation structure is kept - simple and straightforward as this is the first pilot attempt. In line with this, the information flow only contains CWC, the UJVN Ltd. HQ and the Ichari Dam office.

i) Ichari Dam Site Official

There are one executive engineer, three junior engineers and 15 operators in the Ichari Dam office. Normally, the Ichari Dam is operated and maintained in 24 hours by the three operation teams. Each team comprises 5 to 6 operators under the supervision of a junior engineer. These teams are working on three-shift basis. The executive engineer is the overall in-charge and supervises. The structure of the officials working at Ichari Dam is shown Figure 10.

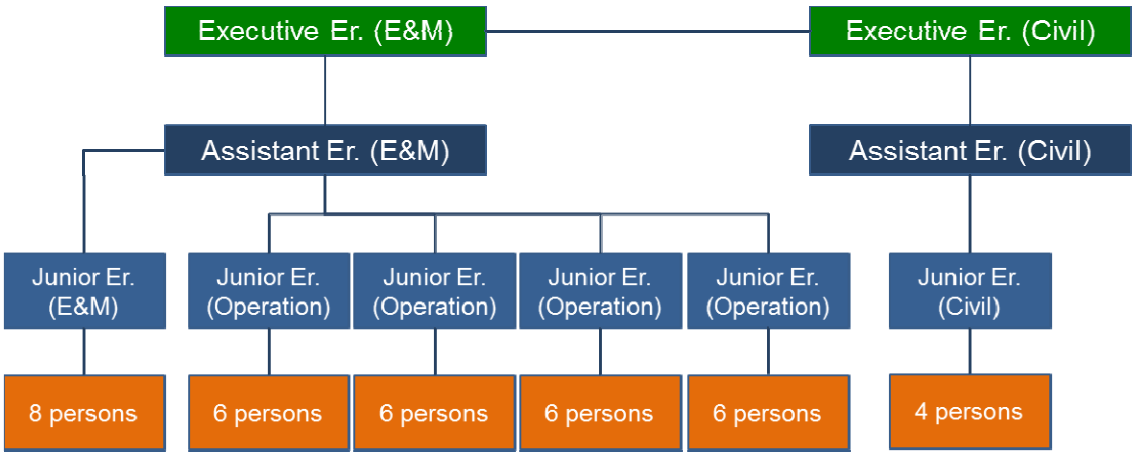


Figure 10 Organization chart of the Ichari Dam

The role of the official working at Ichari Dam after a significant earthquake is to collect and deliver objective information with a sense of mission and to facilitate correct judgement to be made by senior management of agencies.

For establishing a functional emergency inspection system, the distance from officer's residences to the dam site needs to be considered, which would be part of a critical path of the earthquake response time line. The resident area of operators and junior engineers are located at *Koti,* 2km from the Ichari Dam, which is in good accessibility to the dam site.

However the executive engineer and assistant engineer normally work in the branch office of UJVN Ltd. in Dakpathar, where their residences are also located. In the case of the emergency, they must rush to the Ichari Dam by car, to manage officials at dam site and consult with the of UJVN Ltd. HQ. If any serious damage or situation were found, the executive engineer would need to take action by following the Emergency Action Plan.

ii) The headquarters of UJVN Ltd.

The UJVN Ltd. HQ manages many facilities for electric power generation in Uttarakhand State and provide technical advices to these facilities including Ichari Dam. The HQ is responsible for integrating all information regarding the state of dams and transferring to the central government, namely CWC.

The UJVN Ltd. HQ is also responsible for communicating with Indian Meteorological Department (IMD) to receive information on the occurred earthquake. If any dam seemed to get some damage, the HQ needs to manage this issue following the Emergency Action Plan.

iii) Central Water Commission

CWC shall integrate all the information on the state of dams in India. If any urgent issues were emerged, CWC will work with related agencies to minimize any negative impacts. After emergency phase, CWC will review the disaster management carried out and update systems required. Currently, CWC is in charge of establishment of the Emergency Action Plan (EAP) for all dams under DRIP.

iv) District Disaster Management Authority

DDMA primarily supports life of general public from disaster management perspective. Since it is important to protect people in the downstream of a dam from any disaster, the DDMA is involved in the information flow as a counterpart agency of UJVN Ltd.

6.4 Quick Check

i) Objective

The objective of "Quick Check" is to deliver very preliminary report on dam safety to the senior management and disaster management concerned agencies as soon as possible. In this sense, the check items be reported must be limited to the most basic information such as observed seismic intensity and obvious damage observed with only the quickest glance. Medium or long term safety of dam body needs to be confirmed through the first inspection and subsequent normal daily check.

ii) Checklists

The checklists mainly consist of checking seismic intensity observed at the Ichari Dam and external visual checks. It needs to be noted that there is no seismometer placed at the Ichari Dam currently, but it is anticipated that UJVN Ltd. plans to install soon.

The following points shall mainly be checked very quickly by judging from

appearances.

- ✓ External appearance of dam body: Stability and water tightness of dam body are cores of dam safety. Any noticeable deformation, leakage from dam body and boundary between the dam and its foundation shall be quickly checked visually.
- ✓ Reservoir and surrounding mountains: A serious earthquake occasionally leads to landslides which can cause high wave giving additional hydraulic pressure to the dam and create an unstable natural dam which will be easily breached and will flush downstream. It is important to carefully watch the upstream of the dam body to know the initial state of the reservoir.
- ✓ Gates and valves: Any distinct change on leakage from the gates and valves should be checked.]

iii) Manual

The manual was developed in consideration with following points.

- ✓ The traffic line for officials of Ichari Dam is sketched in manual. By following this line, he/she can carry out the inspection in very short time.
- ✓ The existing CCTV can be used for Quick Check.
- ✓ As there is no facsimile installed in Ichari Dam operation office. The result of quick check shall be sent by e-mail.

The Checklist and Manual are attached in Appendix 5.

6.5 First Inspection

i) Objective

The aim of the first inspection is to confirm the functionality and safety of the Ichari Dam. If some serious issues were found during the inspection, changes in operation of dams such as urgent shut down of generator can be made. If worse, additional staff should be urgently sent from the UJVN Ltd. HQ or CWC to the dam site.

In order to meet the above objective, the field engineers need to check structures such as the dam, roads, intake, gates, valves and telecommunication systems. Preferably, color of the reservoir and surrounding mountains are also to be checked.

ii) Checklists and Manuals

The checklists and manuals are prepared in three parts namely for civil engineering structure, mechanical facilities, and electric & telecommunication facilities.

Civil Engineering Structures

- **Checklist**

  In general, deformation, change of leakage and uplift from base rock shall be listed as check items and monitoring systems for these should be appropriately installed and maintained. In the case of the Ichari Dam, only the change of leakage can be measured.

  Therefore, the checklist mainly consists of measurement of leakage at the bottom of inspection gallery, and visual external inspection of downstream surface of the dam and of boundary zone between the dam body and rock foundation. Practically, these checks will be carried out as follows.

  - ✓ Any change of leakage in the inspection gallery and newly created cracks on the dam surface shall be visually checked. ,
  - ✓ Same as the Quick Check, it is important to check the reservoir and mountains to confirm neither landslide nor omen.
  - ✓ In the first inspection, a simple check of presence of land slide is needed by moving to the upstream of the reservoir.

BOX 1 Drainage pump and leakage monitoring of Ichari Dam

The Ichari Dam has a drain pit with automatic draining system as intermittent basis. By checking the interval of this system operation, it would be possible to catch any changes of leakage before and after an earthquake.

However, it takes some time to fill the pit for estimating the amount of leakage and the data to be acquired would not be sufficient for tracing cause since the data represent only the total amount of leakage and water from drain hole, not show where it comes from. That is why the data of drainage pump cannot be used in the first inspection. It is preferable to regularly record and process the leakage of each available drain hole at least as a preparation for emergency situation.

In this context, it is recommended to install triangular weirs at appropriate points to catch the amount of leakage quantitatively.

- **Manual**

  Same as the quick check manual, the traffic of the field engineer is illustrated in the manual taking into account following points, which will facilitate a smooth and secured inspection to be conducted.

  - ✓ Indicating fixed positions and directions to observe the dam and the others,
  - ✓ Delineating places to be checked,
  - ✓ Listing requisite tools for appropriate preparation of inspection,
  - ✓ Describing as short as possible for easy understanding, and
  - ✓ Using very simple words for those who do not have expertise.

Mechanical facilities

The major objective of the manual for mechanical facility is for confirming the operability of the gate and valve for flood control and water supply.

- **Checklist**

  The major check items in the checklist are the gate system and the drain pump.

- ✓ The check items on the gate system covers strain of gate, kink of wire rope, and function of the system by testing the local operation board and remote operating board.
- ✓ The drain pump located at the bottom of the inspection gallery should be checked to avoid the inundation by water leakage.
- ✓ In case of additional emergency inspection or any rescue, the condition of the inspection boat should be checked.

➢ **Manual**

The Ichari Dam has several gates and mechanical facilities including seven spill way gates, three flash gates, and four intake gates. The track line with checking in order is drawn in the manual for time efficient and accurate inspection.

Screen information of operation board is attached to support visually.

Electric and Telecommunication devices

The main objective of the check on electric and telecommunication devices (E&T) is to secure power supply for dam operation and communication line between the Ichari Dam and related entities including UJVN Ltd. HQ and CWC.

➢ **Checklist**

Following items shall be checked with the checklist.

- ✓ Regarding the power supply, both access & transformation equipment, and the emergency generator shall be checked. The emergency generator shall be confirmed its operation.
- ✓ Telecommunication system is composed of only a commercial line. In the emergency case, the mobile phone is normally used for the communication between field engineers to the UJVN Ltd. HQ
- ✓ The status of the monitor of operation panel, SCADA and CCTV also should be checked.

- **Manual**

  The manual for E&T show the track line for officials to make a prompt check, same as the manual for civil engineering structures and the mechanical facilities.

  For prompt understanding of official, some examples of the display on the operation panels and CCTV system are shown on the manual.

  The Checklist and Manual are attached in Appendix 6.

7. Field Drill Scenario and Implementation

7.1 Objective

Using the developed checklists and manuals, the field drill for Ichari Dam was conducted by UJVN Ltd. with support of JWA team. The objective of this drill is to make all officials concerned familiarize earthquake correspondence and to verify the applicability of the developed checklists and manuals. These documents shall be revised subsequently for the next drill. All these activities are based on JWA's actual experience in Japan and it can be said KAIZEN[2] approach.

JWA team support the field engineer of India to organize the scenario and conduct the field drill through Japanese experience.

7.2 Mission Itinerary

The mission itinerary is shown on Table 4. The pillar of mission was conducting the field drill at Ichari Dam and the UJVN Ltd. HQ. For confirming the drill scenario, getting feedback after the drill and sharing JWA's experiences, some workshops and meetings were held during the mission.

[2] KAIZEN in Japanese means continuous improvement. It is recognized worldwide as an important pillar of an organization's long-term competitive strategy.

Table 4 Mission Itinerary

Date		Itinerary	Accommodation
12 Oct	Tue	Departure from Narita for India by NH827	
13	Thu	Arrival at Delhi The meeting with CWC Departure from Delhi for Dehradun	Dehradun
14	Fri	Site Inspection and meeting at Ichari Dam for the adjustment of Manual and Scenario	Dehradun
15-16	Sat Sun	Documentation	Dehradun
17	Mon	Rehearsal at Ichari Dam and UJVN Ltd. HQ	Dehradun
18	Tue	The field drill at Ichari Dam and UJVN Ltd. HQ	Dehradun
19	Wed	Preparation work for The work shop	Dehradun
20	Thu	The Workshop with Engineers of Uttrakhand State Departure from Dehradun for Delhi	Delhi
21	Fri	The meeting with World Bank	
22	Sat	Departure from Delhi for Japan by NH0828	

7.3 Scenario

The scenario is a kind of timeline consisted of required actions to be done by the officials concerned after the significant earthquake. This time, the scenario assumed that an earthquake of M7.4 at the Uttarakashi would occur on 9 am and 150 gal (cm/sec^2) of acceleration would be observed at the bottom of dam. The assumed earthquake was set with reference to the historical earthquakes near the Ichari Dam.

The scenario was drafted by JWA and finalized through discussions with CWC and UJVN Ltd.. In the discussion, responsibilities and roles of related organizations and every official were clarified. In fact, this process is one of the cores for establishing firm and active emergency response system. The detailed scenario is attached in Appendix 7 and outline is presented in Figure 11. The relation between the drill and the EAP which had

been already developed in the DRIP was clearly drawn in this figure.


Photo 6 Meeting at CWC and Ichari Dam

The scenario can be divided into three phase; “initial communication immediate after the strong quake at 9 am”, “Quick check and reporting” and “First inspection and reporting”.

Additionally, the scenario contained the emergency responses against damages such as increasing leakage from a drain hall and a crest gate, high turbidity observed in the reservoir, and significant landslide etc. These actions and collected information shall be continuously linked to the EAP.

Participants of the drill were officials of Ichari Dam and persons in charge of emergency response in UJVN Ltd. HQ and CWC who need to take actions in an actual emergency case. It was expected that the skill for seismic event response would be effectively transferred to the related officials. The final scenario and the list of participants of the drill are attached in Appendix 7 and 8.

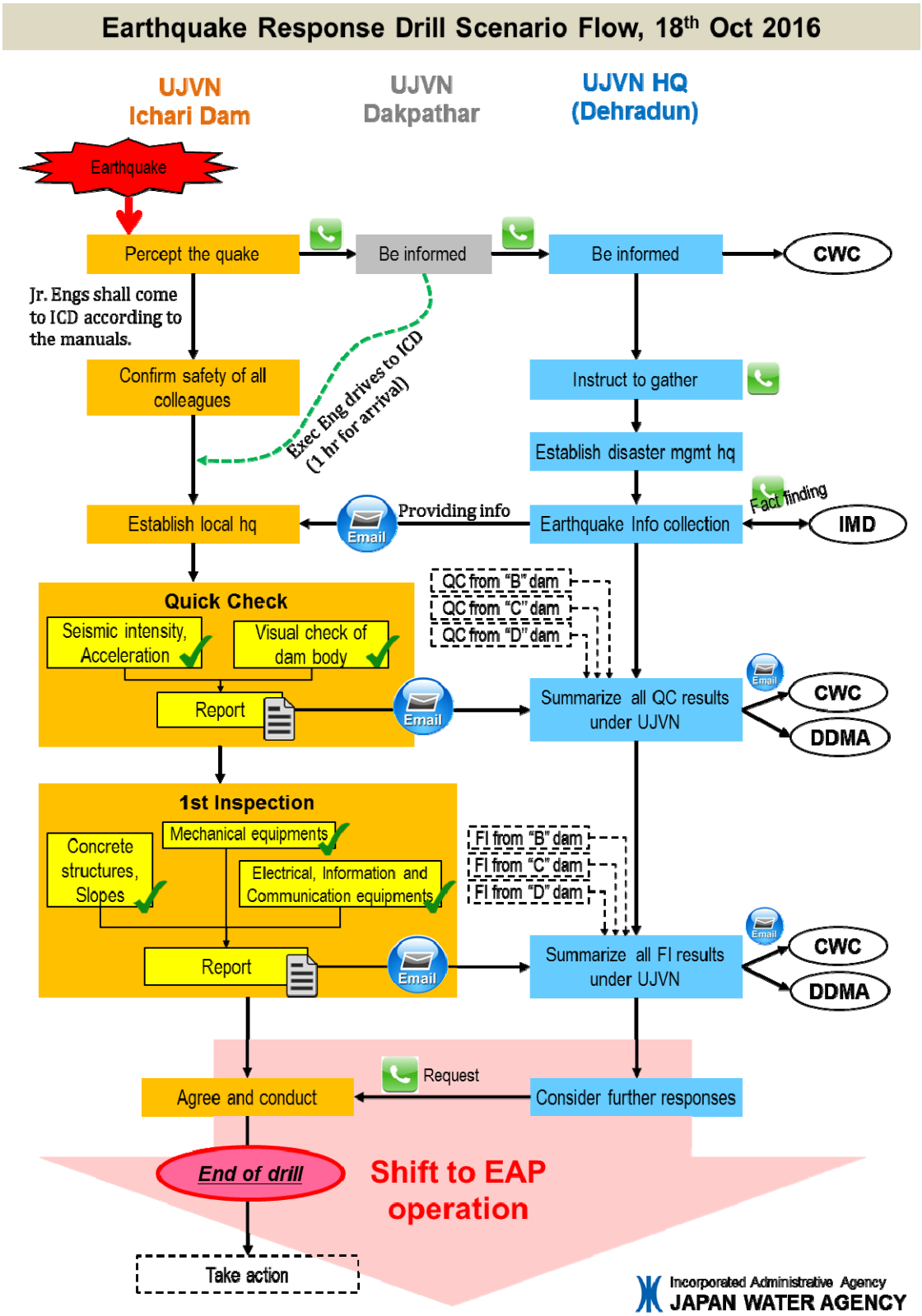


Figure 11 Drill Flow

At the time of the field drill, the seismometer has not yet been installed. However the scenario was developed assuming seismometer would be functional since installation of seismometer had been already planned under the DRIP.

7.4 Field Drill

7.4.1 Rehearsal

The day before the field drill, the rehearsal was conducted to make all the officials well known about the drill, its scenario and their roles.

JWA team conducted the rehearsal of emergency inspection with civil engineer, mechanical, electric and telecommunication engineers, using Check list and the Manual, to make them recognize the action and responsibilities in the field drill.

Two officials participated in the meeting at the UJVN Ltd. HQ, and 12 officials participated in the rehearsal at the Ichari Dam.

Through these meeting and rehearsal, participants were able to have clear picture of the drill and deeply understand the role of each member. As a result, the drill was carried out smoothly following the timeline in the scenario.

Photo 7 Rehearsal at Ichari Dam and UJVN Ltd. HQ

7.4.2 Implementation of the field drill

At the day of the field drill, JWA teams were divided into two teams to observe the state of progress of the drill at the Ichari Dam and the UJVN Ltd. HQ respectively. However JWA

teams did not basically provide any support to the participants because of expectation of autonomous implementation.

In addition to the drill participants, around 30 DRIP delegates from other states were invited to Ichari dam to observe the implementation of the field drill. JWA prepared safe vests for all drill participants to raise awareness on safety environment. As a result, these were very useful to identify the drill participants among many observing delegates.

The drill was started by the JWA's announcement which informed perception of quake. Then, the executive engineer at Dakpathar was informed from a official of Ichari Dam. After communicating with persons concerned, he headed to the dam around 30km far from Dakpathar. This aimed to start the drill from the regular situation.

Basically, head of each dam such as the executive engineer in Ichari Dam is a focal person for communication with other entity and instruction to his/her staff.

Followings are the photos during drill. The planned and actual time are presented on each of them.

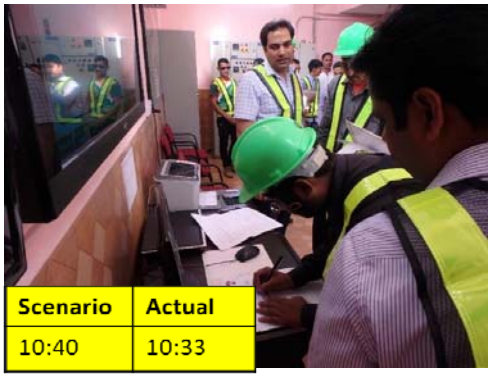
According to these, it can be realized that the information from Ichari Dam to UJVN Ltd. HQ after the first inspection was delayed. This is due to the low capacity of communication line through the satellite system.

Actual reports written by participants and time record are attached in the Appendix 8.

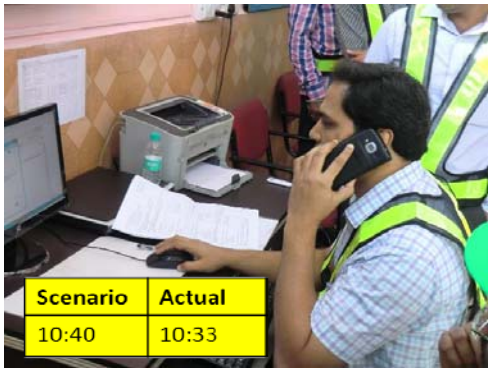
Report from Jr. Eng. To Exec Eng.

Arrival and instruction of Exec Eng

Quick check start



Record of Quick check



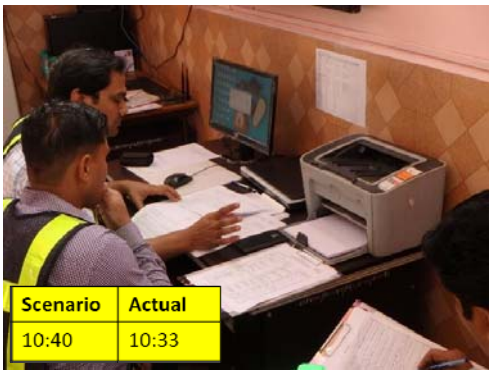
Report to UJVNL-HQ

Receipt of report at UJVNL-HQ

First Inspection of Civil group

First Inspection of Mech. group

First Inspection of E&T group



Report to UJVNL-HQ

Photo 8 Photos of the field drill and Implementation time

7.4.3 Feedback Meeting

After the field drill, evaluation meetings were held in the UJVN Ltd. HQ and Ichari dam to get the feedback from the field drill and to find points to be improved for the next time. A lot of positive and constructive comments were provided by the participants, which are summarized as below.

7.4.4 Feedback from UJVN Ltd. HQ

i) The report sending to CWC should be summarized by UJVN Ltd. HQ from respective reports. The form for this is required in advance.
ii) It is required to make another rule in case of quake perception at Dakpathar even if no notification from Ichari Dam.
iii) It needs to be considered how to share information and emergency tasks within UJVN Ltd. HQ members.
iv) Due to restriction of communication line capacity through the satellite system, it would be better dividing into a couple of messages or scanning in lower resolution. Broadening the internet line capacity is also good, if possible. (This issue was also raised from Ichari Dam)
v) For appropriate work sharing and technical support to the field engineers, UJVN Ltd. HQ expert team should be organized from initial phase.

7.4.5 From Ichari Dam

i) For confirming the safety of officials and their families, the executive engineer should contact junior engineers in Kotti colony after receiving information of

earthquake from Ichari dam.

ii) Taking into account preparation time, it needs 1.5 hour to arrive at Ichari Dam from Dakpathar after receiving the notification.

iii) The Quick Check does not require expertise, so it should be urgently implemented by a junior engineer before arrival of the executive engineer.

iv) In order to shorten first inspection time, the number of officials in each inspection group should be reviewed according to quantity of work.

v) The operation of Ichari dam is directly linked with the operation of Chibro Power St., so the officials of Chibro Power St. should be involved in the future drill.

8. Recommendation

Followings are recommendations from JWA team based on the experience in Japan. Most of these have already shared with UJVNL engineers and CWC officials in the workshop and meeting.

i) Reiterating drills and upgrading earthquake response system

Once a great earthquake happened, there will be hundreds of thousands of victims which may include officials managing dams and their families. However, the job responsibility of dam managers will remain even in such a case. Breaching a dam or electric power supply failure will cause secondary damage to general public. Comparing with other disasters, earthquake is very destructive and not predictable but it will surely happen in potential earthquake places sooner or later.

It is broadly said that preparedness can mitigate disaster damage. It is true, but hard to implement since the damage by an earthquake may spread extremely wide beyond your imagination. In addition, most of the potential areas have less opportunity to meet actual earthquake because of its infrequency. It implies that people have only limited experience on earthquake and cannot prepare appropriately.

In order to fill the gap of this inexperience, regular drill is one of the effective and practical ways. A drill provides people an opportunity to get some experience on disaster. Every drill gives a chance to identify what is missing where the gap is, what can be improved for better disaster management. Regular and repetitious drill using continuously upgraded scenario will be a practical approach to enhance

disaster resilience of all the people concerned.

ii) Securing exclusive communication line

Immediate after any significant disaster, commercial communication line such as mobile phone or fixed phone will be hard to use due to extremely concentrated telecommunications. After the disaster, people seek information relating to the occurred disaster. In particular, the safety information of his/her family and relatives will be the top priority for every person. As a result, the concentrated telecommunication becomes a serious obstacle for managing the disaster. In the case of 2011 earthquake in Japan, it is said that there were more than 60 times larger amount of telecommunication traffic than usual, and only 5 % of them was succeeded.

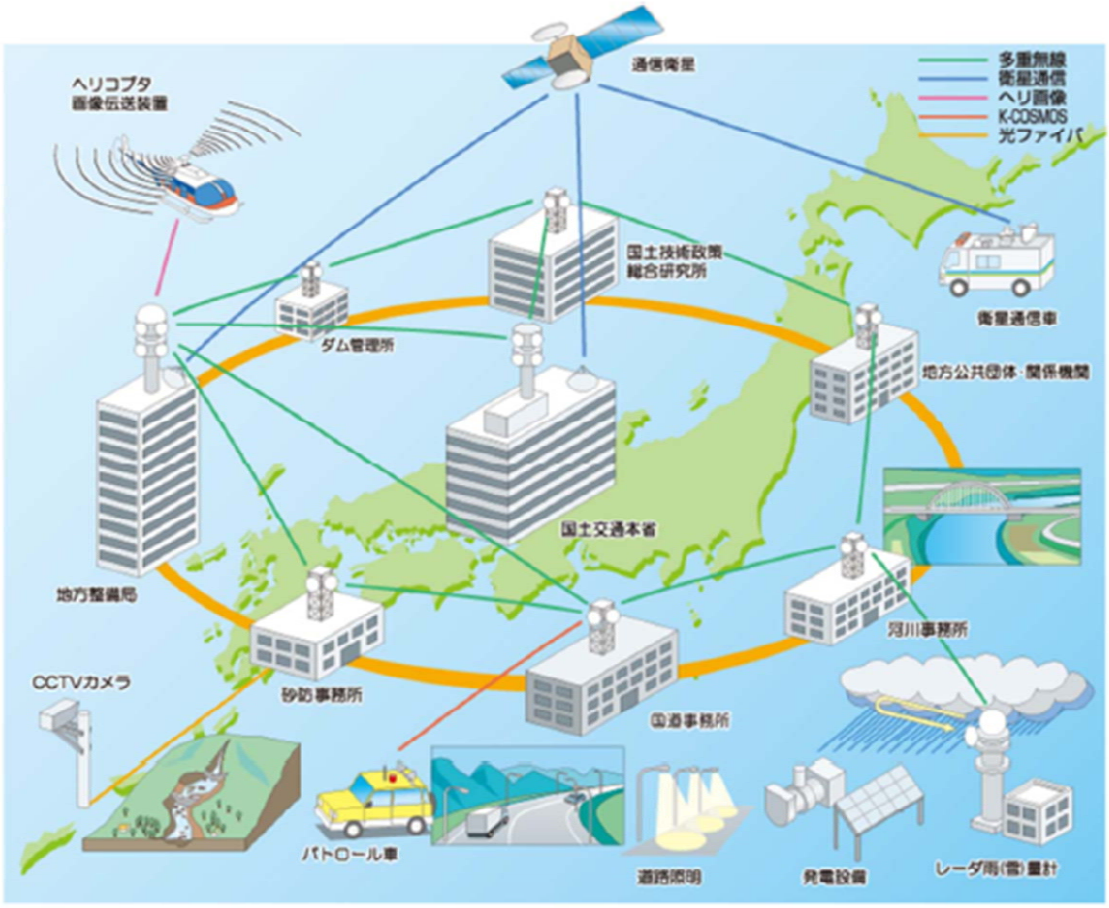
Ministry of Land, Infrastructure Transport and Tourism (MLIT) in Japan develops its exclusive communication network in order to secure the communication from the Cabinet to its field offices (see Figure 12). The network includes dam, river and road management offices, prefectural governments, and municipalities. It is composed of satellite, radio communication, and optical fiber cable according to application and use. JWA is also under this umbrella, covers cost for constructing and maintaining its own facilities.

Satellite is reliable against disaster, but it is very much costly and has very limited traffic capacity. Optical fiber cable has large capacity for transmission, but has high risk to be cut by landslide or floods. Optimal mix of these technologies is one of the keys for establishing a reliable and useful system.

Relating to this, the observed earthquake data at a dam shall be sent through exclusive radio communication such as a satellite, and should not rely on cable communication. This data will be the most important for decision maker, so need to be delivered securely.

As another securing communication line, some mobile phone carrier may be able to provide priority line for designated disaster management organizations by imposing restriction on commercial line. If a similar service is available in India, it would be better for a dam manager to consider using it.

It is the most important that redundancy of communication lines is helpful in an emergency situation. Having two lines is better than single line. Having three communication ways is more secure than only two ways.



Source: Ministry of Land, Infrastructure, Transport and Tourism, Japan

Figure 12 MLIT exclusive communication system

iii) Acquiring leakage data

If it is needed to diagnose the safety of a concrete dam, there are three basic indicators to be considered, namely leakage, uplift and deformation. Among these, leakage which includes drainage from base rock and leakage from concrete joints and other cracks could be the most tangible and sensitive indicator. The point is continuous, consistent and reliable data which can be a base for subsequent analysis and technical judgement. In principle, there should have been series of data since initial ponding.

In this context, it is firstly recommended as a permanent measure to place triangular weirs at the both sides of drain ditch in the inspection gallery and to store the data of them. The automatic data transfer system may help secure daily consistent data acquisition.

Additionally, drainage holes in the gallery should be kept in healthy condition and measure the leakage volume at least once a month. In general, a drainage hole easily be clogged and needs appropriate maintenance such as cleaning or re-bore a hole.

In the case of Ichari Dam, although there is no such available system, the operation record of drainage pump at the bottom of gallery can be utilized. Fortunately, they have already stored for more than several years data, which will help to see the trend of total leakage in the gallery.

Figure 13 shows the estimated total leakage and drainage using operation record of drainage pump. The total leakage is around 40 liter per minute and seems very stable basically. As far as only looking at this data, it could be said that the Ichari Dam seems to be in safe condition. If there are additional data such as water level and external temperature, further detailed analysis and reliable safety assessment could be made.

It should be noted that this is only “total” leakage. Even if frequency of drainage pump operation would be increased after the earthquake, it would not be identified where the water comes from and what kind of countermeasure should be effective. That is the reason why section wise monitoring using a couple of triangle weirs are recommended.

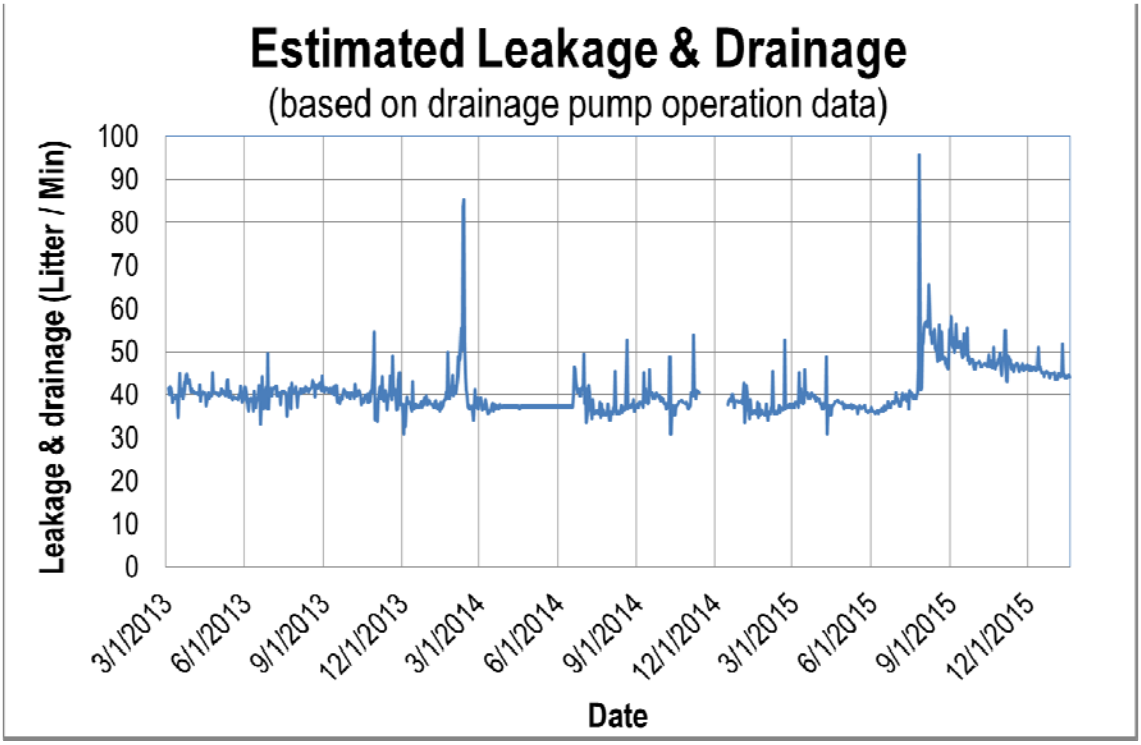


Figure 13 Estimated Total leakage and drainage of Ichari Dam

iv) Recording cracks

In order to find newly appeared cracks by an earthquake or another disaster, it is effective to have a sketch map of existing cracks with attaching their photos on a regular basis such as every three or five years. Figure 14 is a sample of a crack map. In order to make this, some help of an experienced expert will be needed.

One of the easiest ways for recording any change on a dam is to take photos of downstream slope regularly from fixed points. By comparing old photos, newly emerged cracks after the shock will be identified.

Recently, multi-copter so called a drone begins to be used for diagnosing health of large scale infrastructures. JWA has started to use this for dam inspection since a few years ago, but now still on the initial developing stage.

Source: Japan Water Agency

Figure 14 Sample of crack map

v) Securing fuel in the emergency power generator for 72 hours operation

In general, it is said that initial 72 hours after a disaster or severe accident is very important. In the initial 72 hours, saving human life will be placed the first priority and public-help will not reach to remote area. Major recovery works will not be initiated during that time. Power failure will last for long time due to collapsed transmission tower or closed road. Petrol and diesel oil would not be delivered to any gas station. After three days, it would be expected that scale of damage by the earthquake may be clarified and some roads and supply may be recovered. The Japanese government recommends general public to store water and foods for three days as self-help.

For dam managers, it needs to be assumed that no supply and external support will be provided to dams which will be isolated. In the case of Japan, a dam usually stocks three days foods for staff members and fuels for an emergency generator in order for the dam to be functional at least for 72 hours without any supply and

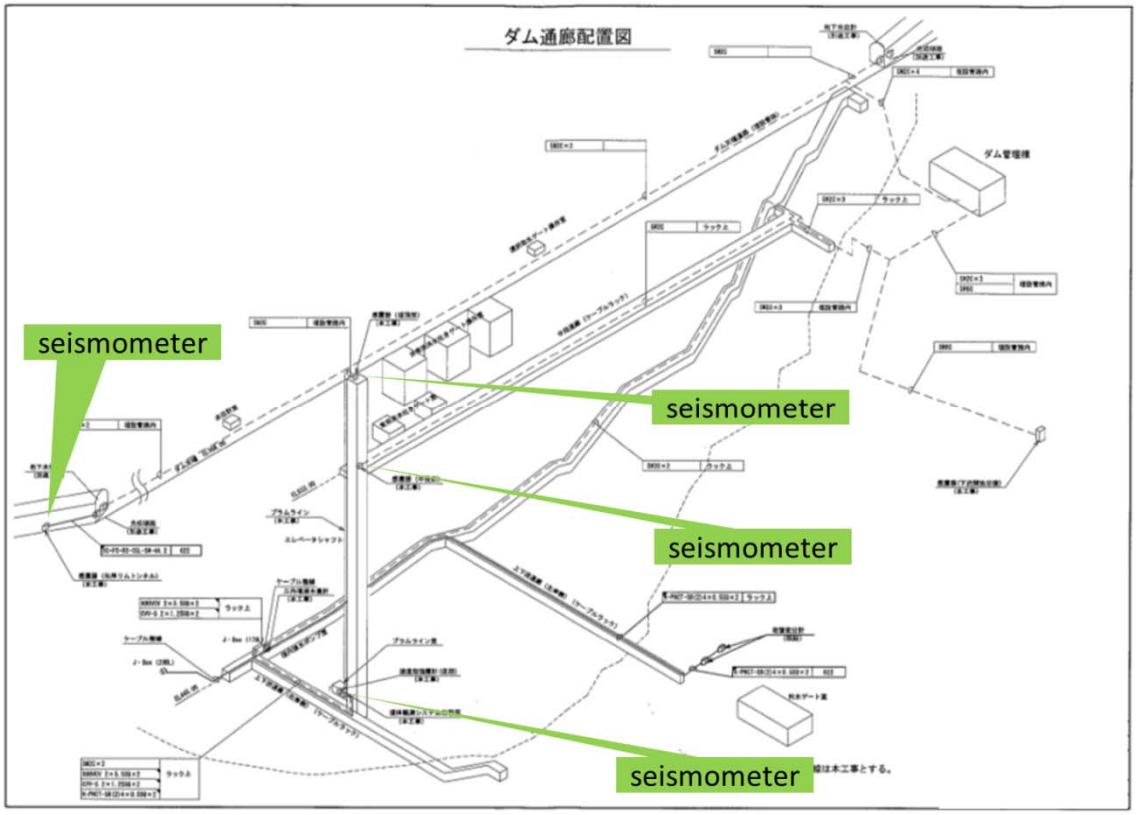
external support.

vi) The installation of seismometer and development of data sharing system

As already mentioned, a dam with massive stored water is one of the caution needed structures when a significant earthquake has occurred, which has potential to cause secondary damage in the downstream. In that sense, required facilities needs to be installed in peacetime.

Damages by an earthquake cannot be presumed only based on magnitude at epicenter. Distance from epicenter or geological features will affect seismic intensity and acceleration at each place. In order to correctly evaluate dam safety comparing with designing condition, it is essential to observe accurate seismic intensity and acceleration at the dam site.

Figure 15 is a sample from Japan. In this case, there are four sensor module of seismometers installed at the bottom, middle and top in the dam, and on the base rock. All the data can be automatically sent to the main system placed in the operation office near the dam. This time, the drill was conducted assuming that the seismometer system had been already installed. However, it is expected that



Source: Japan Water Agency

Figure 15 Sample of seismometer layout

vii) Next step for dissemination of the earthquake response in India

This assignment was the first attempt to adapt earthquake response for dam safety in India, and seemed successful and useful. However, it would be hard for local engineers to autonomously prepare and implement a drill based on only one experience. In this context, dissemination of this exercise will be the next strategic step. There will be two approaches considered by the JWA team.

The first one could be said a vertical approach. It would be effective to enhance the drill by carrying it out every year at Ichari Dam or another dam in Uttarakhand state. By repeating the drill in the same states, the knowledge on earthquake response will be accumulated and its capacity in terms of human resources and required facilities will be developed. Since Uttarakhand state is located in a high potential earthquake zone, it could be an advanced state regarding seismic safety of dams in India, and the other states can learn from this state. It would be one option to establish the center of excellence (COE) in this state under CWC. The

COE will lead earthquake response for dams in India and provide technical guidance and trainings for all dam managers.

The second option would be a horizontal approach. The safety check items should vary for every dam depending upon dam type, scale and other conditions. The Ichari dam is a middle scale concrete gravity dam, so it would be useful to focus on another typical dam such as a rock-fill type dam or a combined dam which can serve as another model in India. In the new site, the same type of drill can be conducted in other states in collaboration with CWC.

Above mentioned options can be taken in parallel. By implementing drills several times, it is expected that the knowledge on earthquake response and dam safety monitoring will be transferred and stayed in India. Also, the required monitoring facilities such as seismometer, drain holes in an inspection gallery and telecommunication network for emergency response will be prepared.

Appendix

Appendix 1

Case study on earthquake correspondence in Japan

Case study on earthquake correspondence in Japan

First of all, it should be clearly mentioned that there is no Japanese dam collapsed which meets the modern technical standard of Japan.

Every 1st September is defined as the disaster preparedness day in Japan. This is the day of organizing large scale drill on earthquake correspondence for most of all organizations such as national government, municipalities, other public entities, schools, hospitals and even private companies, and recalling the lessons learned from the past large scale earthquake hit on that day in 1923.

JWA also conducts the earthquake drill involving all dam operation and maintenance offices, branch offices and headquarters. The scale of earthquake for each drill is assumed based on the probable maximum level earthquake projected by the national government. Before and after every drill, disaster preparedness such as equipment, stored food & water and communication tools are reviewed and upgraded if necessary.

Source: Japan Water Agency

Photo of an earthquake disaster drill in JWA

The Case of the Great East Japan Earthquake

At 14:46 on 11th March 2011, the Great East Japan Earthquake hit many JWA dams which received the strong seismic impact requiring emergency checks. One of the 100 meter class high dams of JWA recorded 31 gals acceleration at its basement.

In this case, JWA staff promptly took action for the quick check and report to the JWA

headquarters at 14:55. Subsequently, the first inspection was completed and reported at 17:10, and the second check was completed at 20:05.

After this great earthquake, the dam operation office met several times of power failure which was about nine hours in total. At that time, the diesel oil and petrol was very hard to be purchased. It was a good practice to recognize the importance of storing sufficient fuel and equipping backup generators.

The Case of Kumamoto Earthquake in 2016

The strong earthquake, Mw 6.2, occurred at 21:26, 14th April 2016 in Kumamoto Prefecture in the western Japan. The headquarters of JWA immediately opened the emergency operation center following the JWA's disaster management plan. Following pictures show the states of the disaster operation center in the headquarters of JWA after 1 hour from the earthquake.

Photo of responses for Kumamoto Earthquake in HQ-JWA

This earthquake occurred after working hour, but officials in charge of disaster correspondence were automatically mobilized according to the information from mobile phone which was issued by the Meteorological Service Agency. The information reported from JWA facilities were also collected and shared on the white board.

There is no doubt that preparation of checklists and manuals and continuous drills enable this swift response

Appendix 2

Agenda and Participants list of Consultation Meeting

Agenda of the 1st Consultation Meeting

19th April (Tuesday): Site Survey of Ichari Dam

Date/Time	Subject	Remarks
	(Transport from Hotel to Ichari Dam) Site Survey of Ichari Dam (supported by UJVN Engineer)	JWA Team (The officials of Ichari Dam)

20th April Consultation Meeting (day 1) Moderator: Nobuyuki Ichihara, JWA
(with an India Counterpart)

Venue: The Meeting room of Ichari Dam

Date/Time	Contents	Remarks
10:00-10:30	Opening Remarks/ Outline of Japan Water Agency	Dr. Kentaro Kido
10:30-10:50	Impression and Recommendation by the experience of the exposure visit in Japan	Mr. S.N.Verma, Managing Director, UJVNL
10:50-11:00	Outline of Disaster Management and JWA's effort after the seismic events	Mr. Nobuyuki Ichihara
11:00-11:30	Coffee Break	
11:30-12:00	Introduction of the outline of dam safety Management	Dr. Kentaro Kido
12:00-13:30	Lunch	
13:30-14:00	Management Policy on electric, information, telecommunication and mechanical facilities for dam O&M	Dr. Masahiro Sugiura
14:00-14:30	Outline of the checklists and the inspection manual after the seismic events	Mr. Nobuyuki Ichihara
14:30-15:00	Introduction of the current status of the Inspection procedures of Indian facilities	All participants
15:00-15:20	Coffee Break	All participants
15:20-16:00	Establishment of the appropriate information flow Ichari Dam for Check	All participants
16:00-16:30	Feedback of First day	

21th April Consultation Meeting (day 2)

Venue: The Meeting room of Ichari Dam

Date/Time	Contents	Remarks
09:30-09:50	Summary of Day 1	Mr. Nobuyuki Ichihara
09:50-12:00	Group discussion for drafting the check lists and Manual	JWA team and All participants
12:00-13:30	Lunch	
13:30-15:30	Site Survey with the tentative check lists	JWA team and All participants
15:30-16:30	Group Discussions for the update of the manual	JWA team and All participants

22nd April Consultation Meeting (day 3)

Venue : The meeting room of the Head of UJVN Ltd.

Date/Time	Content	Remarks
09:30-11:30	The presentation about the draft checklist and the Manual and the Recommendation from Group Discussion	All participants
11:30-12:00	Brief Introduction of the next meeting and closing	Dr. Kentaro Kido, Mr. Nobuyuki Ichihara

Participants list of 1st consultation meeting in April 2016

No.	Name	Position	Organization	Area of responsibility	Remarks
1	Dr. Umakant Panwar	Principal Secretary	Department of Energy		At Meeting on 22, April
2	S.N.Verma	Managing Director	UJVN Ltd.		At Meeting on 21,April
3	Dr.A.C.Joshi	Director(HR)	UJVN Ltd.		
4	Mr.Misha,BCK	Director(Operations)	UJVN Ltd.		
5	Mr.Sanjaya Mittal	General Manager (Yamuna Valley)	UJVN Ltd.		
6	Mr. Moh. Afzal	Executive Engineer (E&M)	Ichari Dam, UJVN Ltd.	Mechanical Eng. (Operation & Maintenance of Hydro Mechanical work of Ichari Dam)	
7	Mr. Dharmendra Singh	Executive Engineer (Civil)	Ichari Dam, UJVN Ltd.	Civil Eng. (Maintenance of Civil work of Ichari Dam & Dakpathar Barrage)	
8	Mr. D.S. Karki	Executive Engineer (E&M)	Dakpathar Barrage, UJVN Ltd.	Operation & Maintenance of Hydro Mechanical work of Dakpathar Barrage	
9	Mr. Ajay Kumar	Executive Engineer (E&M)	Assan Barrage, UJVN Ltd.	Mechanical Eng. (Operation & Maintenance of Hydro Mechanical work of Assan Barrage)	
10	Mr. Vikas Bahuguna	Executive Engineer (Civil)	Assan Barrage, UJVN Ltd.	Civil Eng. (Maintenance of Civil work of Assan Barrage)	
11	Mr. Harish Dhapola	Executive Engineer (E&M)	M.B. 1, UJVN Ltd.	Mechanical Eng. (Operation & Maintenance of Hydro Mechanical work of MB-1 Maneri Dam)	
12	Mr. Abhay Singh	Executive Engineer (Civil)	M.B. 1, UJVN Ltd.	(Civil Eng.) Maintenance of Civil work of MB-1 Maneri Dam	
13	Mr. Jitendra Arya	Executive Engineer (E&M)	M.B. 2, UJVN Ltd.	Mechanical Eng. (Operation & Maintenance of Hydro Mechanical	

				work of MB-2 Joshiyara Barrage)	
14	Mr. Shiv Das	Executive Engineer (Civil)	M.B. 2, UJVN Ltd.	(Civil Eng.) Maintenance of Civil work of MB-2 Joshiyara Barrage	
15	Mr. Raj Kumar	Executive Engineer (E&M)	Pashulok Barrage, UJVN Ltd.	Mechanical Eng. (Operation & Maintenance of Hydro Mechanical work of Pashulok Barrage)	
16	Mr. Vinod Bhakuni	Executive Engineer (Civil)	Pashulok Barrage, UJVN Ltd.	(Civil Eng.) Maintenance of Civil work of Pashulok Barrage	
17	Mr. Rajesh Kumar	Executive Engineer (E&M)	Director (Operation), UJVN Ltd., (From Electronic Engineering Background)	Electronic Eng. (Electronic Engineer looking after work of day to day generation of all projects)	
18	Mr. Manoj Rawat	Executive Engineer (E&M)	MB-II Project. (From Electronic Engineering Background)	Electronic Eng. (Electronic Engineer looking after Test work of MB-II projects and knowledge of Scada system)	
19	Mr. Arvind Kumar	Executive Engineer (E&M)	Test Work of Dhakrani, Dhalipur and Kulhal Project.	Electrical Eng. (Electrical Engineer looking after the Test work of Dhakrani, Dhalipur, Kulhal Project)	
20	Mr. Rachit Phartiyal	Assistant Engineer (IT)	Information Technology Dept, UJVN Ltd.	Computer Science Eng. Looking LAN Network and Networking in UJVN LTD.	
21	Mr. Sandeep Rathore,	Assistant Engineer (Test)	Chibro Power Station, (From Mechanical Engineering Background)	Mechanical Eng. (Looking Test Work of Chibro Power House, Earlier knowledge of IT networking)	
22	Mr. K K Jaiswal	Executive Engineer (E&M)	Atatch Officer (General Manager – Yamuna Valley)	Mechanical Eng. (Assisting General Manager – Yamuna Valley for O&M of Chibro, Khodri, Dhakrani, Dhalipur and Kulhal Projects	

				alongwith O&M of Ichari, Dakpthar and Assan Barrage)	
23	Mr. Pankaj Agarwal	Dy. General Manager (Chilla)	Chilla Circle, UJVN Ltd.	Electrical Eng. (Looking after over all operation of Chilla and Pashulok Barrage)	
24	Mr. Nirpendra Chauhan	Dy. General Manager (Dakhpathar)	Dakpathar Circle, UJVN Ltd.	Looking after over all operation of Chibro, Khodri, Dakpathar Barrage and Ichari Dam	
25	Mr. Vimal Kumar	Dy. General Manager (Dhakrani)	Dhakrani Circle, UJVN Ltd.	Looking after over all operation of Dhakrani, Dhalipur, Kulhal and Assan.	
26	Mr. RAVINDRA	Executive Engineer	Chibro	Looking after technical maintenance & Operation System, Chibro Power Station	
27	Dr. A.K.Dhawan	EGIS Dehli	DRIP		
No.	Name	Position	Organization	Job in charge	
1	Dr. Kentaro Kido	Director	Dam eng. Div., Water Resources Eng. Dept., JWA	Civil Eng.	
2	Dr. Masahiro Sugiura	Deputy Director	Int'l Affairs Div., Water Resources Eng. Dept., JWA	Electrical Eng.	
3	Mr. Nobuyuki Ichihara	Deputy Director	Int'l Affairs Div., Water Resources Eng. Dept., JWA	Civil Eng.	

Appendix 3

Materials of Consultation Meeting

The first Consultation Meeting,20-22 April,2016

Outline of Japan Water Agency (JWA)

20 April, 2016

Kentaro KIDO Ph.D.
Director, Dam Engineering Division,
Water Resources Engineering department,
Japan Water Agency

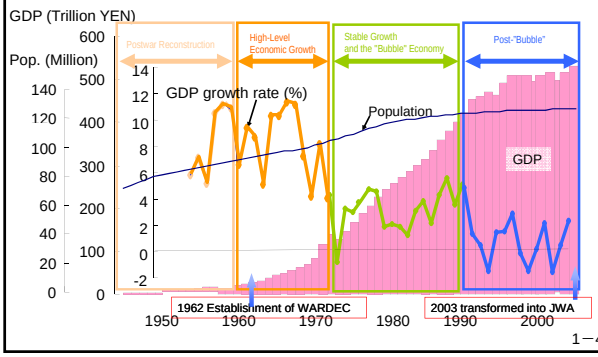
trust funded and administrated by THE WORLD BANK

Contents

1. Outline of JWA

Background of Establishment of JWA

■JWA was established in 1962 in the middle of high economic growth period, when water demand was growing rapidly.



History of Founding of WARDEC*

*WARDEC (Water Resources Development Public Corporation) : Predecessor of JWA

■Background

✓There was the abrupt increase of demand for urban water caused by the drastic development of urbanization and industrialization, changing from the regional water use for irrigation water. Such a demand change caused serious water shortage and the change of application for water use, resulted in frequent water disputes.

✓Serious cases of ground subsidence and water pollution occurred.

→It became necessary to urgently develop the water utilization system on a river basin level in line with the consensus of the society.

■The purpose of the system establishment

✓Promotion of water resources development in wide range of river systems extended to plural prefectures where there were impending water development.

History of Founding of WARDEC

■Water Resources Development Promotion Law (1957)

✓Designates the river systems, where water resources development should be promoted and investment is focused for higher demand.

✓Determines the "Water Resources Development Basic Plan (Full plan)". The Full Plan is determined by the cabinet after the adjustment among the ministries, local governments and councils concerned, etc.

✓Secures the financial funds, by forming the implementing organization to promote the "full plan".

■Water Resourced Development Public Corporation Law (1961)

✓Establishes Water Resources Development Public Corporation as the organization to implement multi-purpose projects at the river basin level, following the decision made on the full plan.

✓Stipulates cost sharing of projects, proportion of grants and subsidies from the national government, and loan system (joint project system).

"The Water Resources Development Basic Plan" (Full Plan)

- Water supply by application; irrigation, domestic and industrial water.
- Water utilization plan by prefectures, etc.

Forecasts of water demand

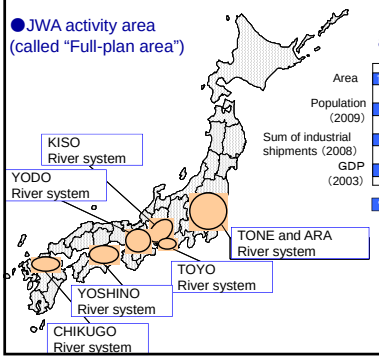
Guidance, Adjustment, Agreement among Ministries in charge and relevant prefectures

"The Water Resources Development Basic Plan"
1) Forecast of demand by water usage and objectives for the next 10 or 15 years
2) Basic matters related to the construction of facilities needed to achieve the objectives for supply

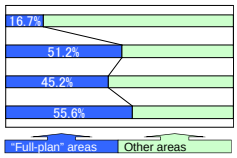
JWA's Share in Japan

■JWA activity areas are seven river basins where "Water Resources Development Basic Plan" is stipulated.

●JWA activity area (called "Full-plan area")



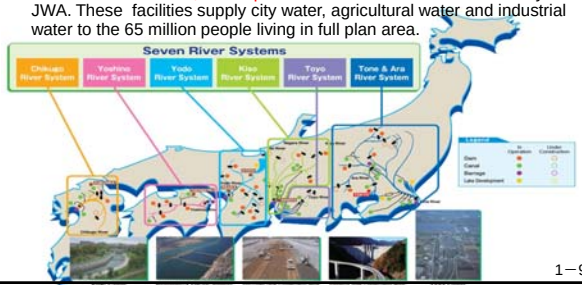
●The share of Full plan area in Japan



Only 17% of the national land area, but about 50% of the population and industrial output are concentrated there.

JWA's Projects

- ✓ JWA is a River Basin Organization and has contributed to water resources management based on the Basic Plan for Water Resources Development for more than 50 years in Japan.
- ✓ JWA has been constructing, operating and reconstructing water resources management facilities for water use and flood control such as dams, weirs and canals.
- ✓ 43 Dams and about 1,000km primal water route were established by JWA. These facilities supply city water, agricultural water and industrial water to the 65 million people living in full plan area.



2. JWA's Technologies

Dams in Japan and around the world

Number of large dams in the world

	Country	Number of dam
1	China	22,000
2	USA	6,575
3	India	4,291
4	Japan	2,675
5	Spain	1,196
6	Canada	793
7	Korea	765
8	Turkey	625
9	Brazil	594
10	Flance	569
	Others	7,572
	Total	47,655

Source: WCD Report (2000)

List of Highest Dams in Japan

Rank	Name	Type	Height (m)	Owner	Completion Year
1	Kurobe	A	186.0	Kansai Electric Power	1961
2	Takase	R	176.0	Tokyo Electric Power	1979
3	Tokuyama	R	161.0	JWA	2008
4	Naramata	R	158.0	JWA	1990
5	Okutadami	PG	157.0	Electric Power Development Co.Ltd	1960
6	Urayama	PG	156.0	JWA	1998
6	Miyagase	PG	156.0	MLIT	2000
6	Nukui	A	156.0	MLIT	2001
9	Sakuma	PG	155.5	Electric Power Development Co.Ltd	1956
10	Nagawado	A	155.0	Tokyo Electric Power	1969

MLIT: Ministry of Land Infrastructure Transport and Tourism
R: Rock fill PG: Concrete gravity A: Concrete arch

Major JWA Dams

Name	Type	Height (m)	Crest Length (m)	Reservoir Capacity (X1,000m3)	Completion Year
Tokuyama	R	161.0	427	660,000	2008
Naramata	R	158.0	520	90,000	1990
Urayama	PG	156.0	372	58,000	1998
Kusaki	PG	140.0	405	60,500	1976
Misogawa	R	140.0	447	61,000	1996
Takizawa	PG	132.0	424	63,000	2010
Yagisawa	A	131.0	352	204,300	1967
Shimokubo	PG	129.0	605	130,000	1968
Iwaya	R	127.5	366	173,500	1976
Tomisato	PG	106.0	250	52,000	2000
Sameura	PG	106.0	400	316,000	1977

R: Rock fill PG: Concrete gravity A: Concrete arch

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JWA Dams and Barrages

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JWA's Technologies

- ✓ JWA has been serving to lead in water resources development and management in Japan with advanced technologies of the water resources management facilities,.
- ✓ Those skills have been fully reflected in appropriate operation and maintenance of those facilities, preventing measures for deteriorating facilities, and environmental preservation measures.

Construction of dam body

Integrated operation of canal system

Examination of PC pipe

Improving water quality by aerating circulation

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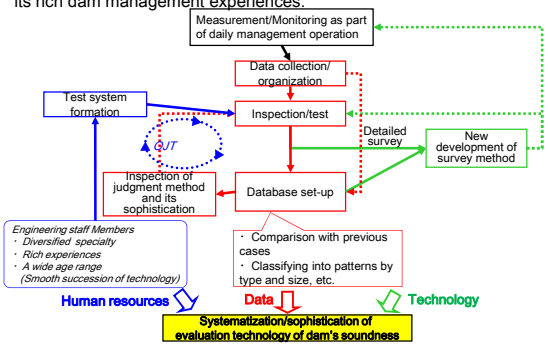
JWA's Endeavour for Advanced Dam Management

- ✓ JWA is advancing the strategic development for stock management based on the dam's safety management system, making use of the advanced engineering powers (data, technologies, human resources) fostered through its rich dam management experiences.



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3. JWA's Contribution in International Cooperation

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Contribution in International Cooperation

➢ Network of Asian River Basin Organizations (NARBO)

- ✓ NARBO is the Network of Asian River Basin Organizations established in February 2004 to promote integrated water resources management (IWRM) in monsoon areas of Asia.
- ✓ NARBO was funded by Japan Water Agency (JWA), Asian Development Bank (ADB) and Asian Development Bank Institute (ADBI). From 2010, Center for River Basin Organizations and Management (CRBOM) joined secretariat.
- ✓ NARBO members: 85 organizations from 18 countries
- ✓ Major Five Activities: Facilitate to establish and strengthen RBOs by information sharing, thematic workshops, twinning program, IWRM training and RBO performance benchmarking.

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Contribution in International Cooperation

➢ **Dispatch of Experts**

✓ JWA has dispatched 72 long-term JICA experts to 19 countries since 1970.

✓ JWA has dispatched many short-term experts requested by JICA or other organizations.

✓ JWA has contributed to International Emergency Aid Group or other emergency dispatch at disasters.
(e.g. Thailand, Vietnam, Philippines)

➢ **Consulting works**

✓ JWA has performed consulting works such as planning, survey and design for enhancement of water management of Asian countries.

- ・Integrated water resources management (IWRM)
- ・Disaster prevention / mitigation
- ・Dam safety

4. Exposure Visits from India

1st Exposure visit

➢ Courtesy call on MLIT (15 Jun. 2015)

➢ Meeting at JWA-HQ (16 Jun. 2015)

➢ Visit to Takizawa dam and Urayama Dam (JWA) (17 Jun. 2015)

・Purpose: Observe how the response is made to an earthquake and view a selective intake facility

2nd Exposure visit

➢ Meeting at JWA-HQ (29 Sep. 2015)

➢ Visit to Yagisawa Dam and Naramata Dam (JWA) (30 Sep. 2015)

・Purpose: Observe how the observation and inspection of the dam body are conducted (at an arch dam and a rock-fill dam).

3rd Exposure visit

➢ Meeting at JWA-HQ (24 Nov. 2015)

➢ Visit to Shimokubo Dam (JWA) (26 Nov. 2015)

・Purpose: Observe the discharge facility and observe how the observation and inspection of the dam body are conducted. (at the gravity dam)

➢ Visit to Miwa Dam and Koshibu Dam (MLIT) (25 Nov. 2015)

・Purpose: Observe how the countermeasures for sediment are conducted (a bypass tunnel)

4th Exposure visit

➢ Meeting at JWA-HQ (8 Mar. 2016)

➢ Visit to Takizawa Dam and Urayama Dam (JWA) (9 Mar. 2016)

: Observe: how the response is made to an earthquake and view a selective intake facility

Roundtable on Dam Safety and Management related to Seismic Hazards and Sedimentation

(11st ,March 2016 at Tokyo Office of World Bank)

Dr. Umakant Panwar, Principal Secretary of Department of Energy,Govt of Uttarakhand, became to sensitize the importance of the maintenance of the Dam Safety and the Necessity of the training for the enhancement of the capacity of Dam safety

JWA believes that the application of the technologies we have built up from our experiences will be a great help in supporting India in improvement of dam safety management.

Makio-dam(JWA) Financial Supported by Word Bank

Instruction by foreign engineers

Thank you.

The first Consultation Meeting,20-22 April,2016

Outline of Disaster Management and JWA's effort after the Seismic Events

20 April, 2016

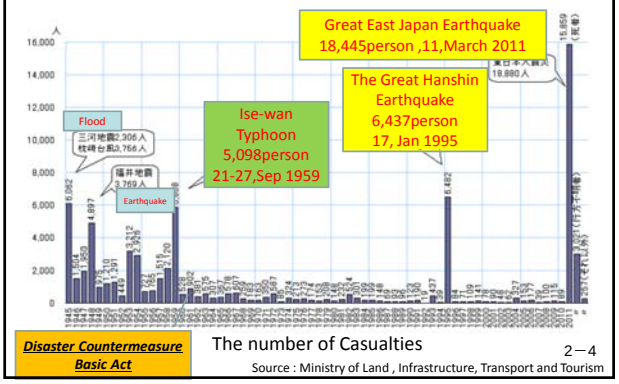
Nobuyuki Ichihara
Deputy Director, International Affairs Division,
Water Resources Engineering department,
Japan Water Agency

trust funded and administrated by

Contents

1. The Framework of Disaster Management in Japan

Historical Disaster in Japan



Disaster Countermeasure Basic Act

The number of Casualties

Source : Ministry of Land , Infrastructure, Transport and Tourism

Disaster Countermeasure Basic Act

Disaster Countermeasure Basic Act (Enacted in 1961)
－Fundamental Act for Government's Disaster Countermeasure
－Triggered by **Isewan-Typhoon (in 1959: 5098 were killed)**

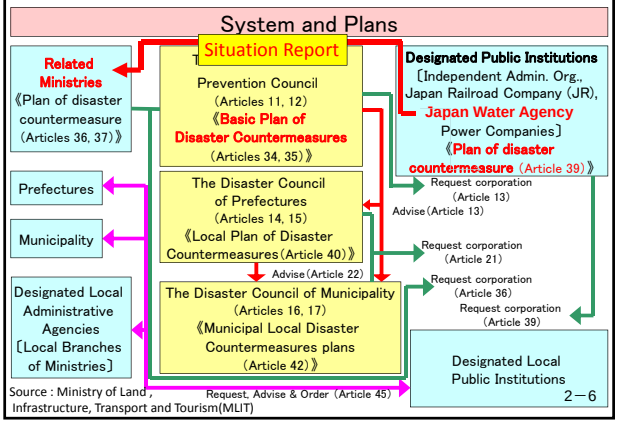
Objectives and Responsibility

Objectives (Article 1):To protect the national land, and the lives, health , and assts of the citizens from disaster, and clarifies the parties responsible for the same. ~ contributing to the development and promotion of comprehensive and systematic disaster countermeasures administration to maintain social order and ensure public welfare.

Source : Ministry of Land , Infrastructure, Transport and Tourism(MLIT)

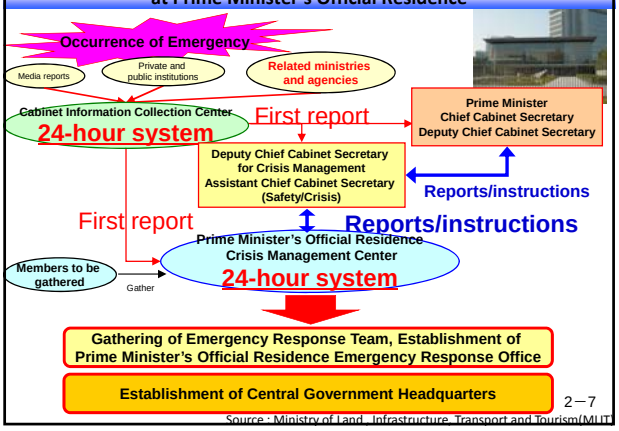
Disaster Countermeasure Basic Act

System and Plans



Source : Ministry of Land , Infrastructure, Transport and Tourism(MLIT)

Flow of Earthquake Response at Prime Minister's Official Residence



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Source : Ministry of Land, Infrastructure, Transport and Tourism(MLIT)

2. The Case Study of the Response for Earthquake

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Tsunami Disaster

The Great East Earthquake

2:46 pm
11 March 2011
Mw 9.0

Source : Ministry of Land , Infrastructure, Transport and Tourism(MLIT)

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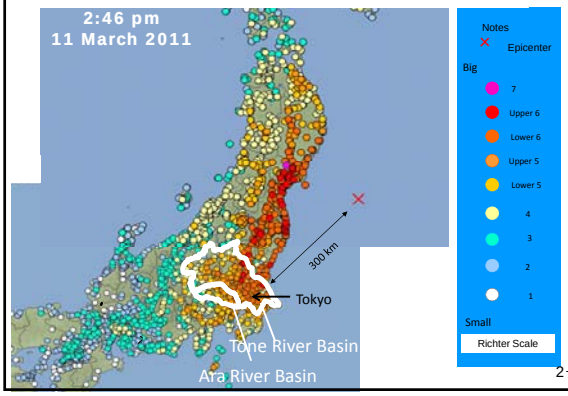
The distribution map of seismic intensity



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Japanese seismic intensity

JSI	MSK-S
0	I. Not perceptible
	II. Hardly perceptible
1	III. Weak
2	IV. Largely observed
	V. Fairly strong
3	
	VI. Strong
4	
5 lower	VII. Very strong
5 upper	VIII. Damaging
6 lower	IX. Destructive
	X. Devastating
6 upper	XI. Catastrophic
7	XII. Very catastrophic

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JSI: Japanese seismic intensity
MSK-s: Medvedev-Sponheuer-Kárník scale

MLIT's Emergency Headquarters

- Established MLIT's Emergency Headquarters at 15:15 (approx. 30 minutes after the quake)
  Chief of headquarters: Minister of MLIT , Members of headquarters : Director-Generals of MLIT's Bureaus
- The first meeting was held from 15:45, March 11. Meetings were held three to four times a day in the period immediately after the earthquake. 49 meetings have been held since.
- Information is shared simultaneously with regional development bureaus nationwide by utilizing the TV conference system.
- Prompt information sharing, quick decision-making and implementation of measurements could be achieved

MLIT's Emergency Headquarters

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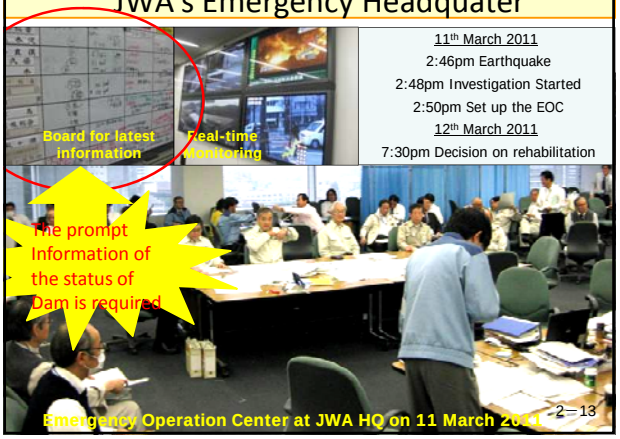
Source : Ministry of Land, Infrastructure, Transport and Tourism(MLIT)

JWA's Emergency Headquater



11th March 2011
2:46pm Earthquake
2:48pm Investigation Started
2:50pm Set up the EOC
12th March 2011
7:30pm Decision on rehabilitation

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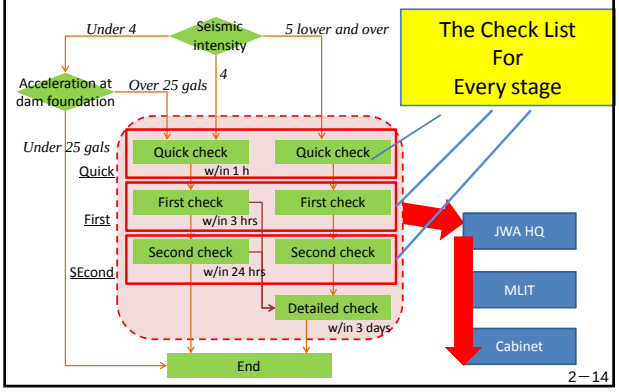
Extraordinary inspection aftermath of great earthquake



The Check List For Every stage

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Technological Assistance for Quick Response

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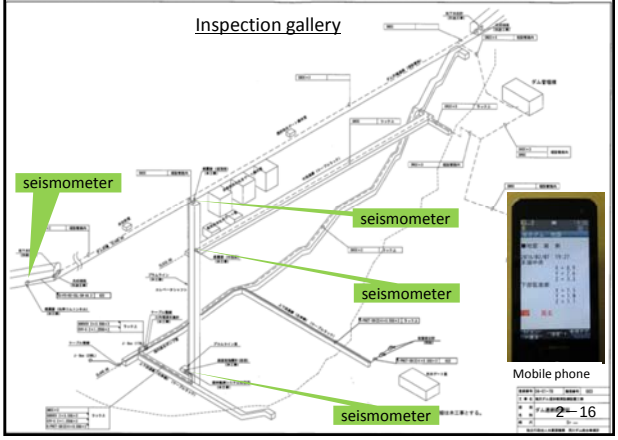
Inspection gallery



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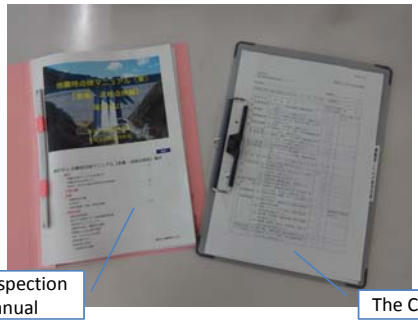
The Check List and The inspection Manual



2－17

The Check list and Manual

- For the Quick Response , the Check List is prepared for every state.
- Check list are formulized for each specialized sector , Civil Engineering, Mechanical Engineering , Electrical Engineering

2－18

The Inspection Manual of JWA

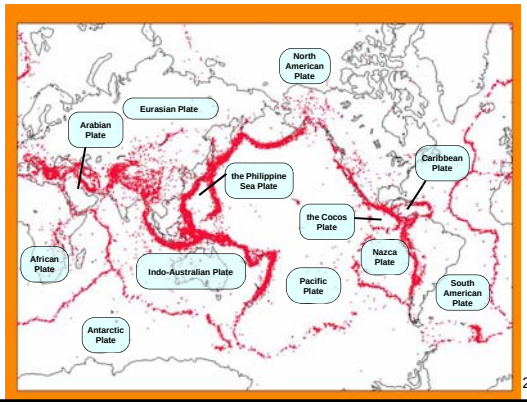
- In order to cover the difficulty of the access of the technical parson in winter season, the Inspection manual was formulized in 2006
- Up to now , this formula was widly spread in JWA's facilities

2－19

3. The Necessity of preparedness for Earthquake in India

2－20

Seismic-center distribution and major plates



2－21

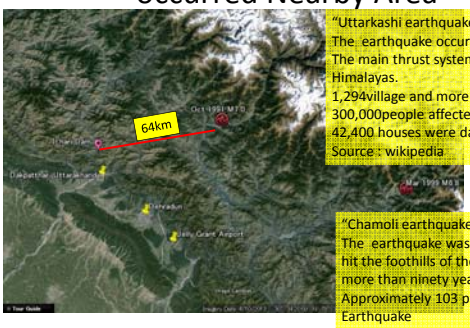
Earthquake Zone in India

- Ichari Dam is located seismic zone 4.(High Frequency)

CC-by-sa PlaneMad/Wikimedia
https://en.wikipedia.org/wiki/Earthquake_zones_of_India#/media/File:India_earthquake_zone_map_en.svg

2－22

The Location of Historical Earthquake occurred Nearby Area

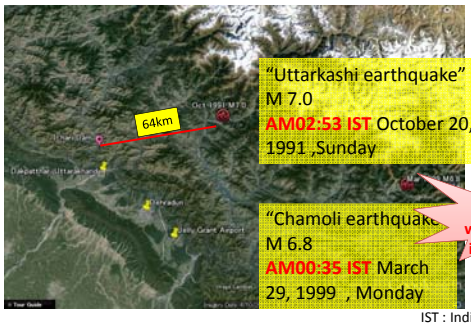


"Uttarkashi earthquake"
The earthquake occurred within The main thrust system of the Himalayas.
1,294village and more than 300,000people affected with the quake, 42,400 houses were damaged
Source : wikipedia

"Chamoli earthquake"
The earthquake was the strongest to hit the foothills of the Himalayas in more than ninety years
Approximately 103 people died in the Earthquake
Source: wikipedia

2－23

The Earthquake in office Hour is rare!



"Uttarkashi earthquake"
M 7.0
AM02:53 IST October 20, 1991 ,Sunday

"Chamoli earthquake"
M 6.8
AM00:35 IST March 29, 1999 , Monday

The Earthquake will never com in office hour

IST : Indian Standard Time

The Preparation in the normal activity is very important

2－24

The law for Disaster Management in India

- **The disaster management act,2005**.
- "**disaster**" means a catastrophe , mishap , calamity or grave occurrence in any area , arising from national or man made causes , or by accident or negligence which results in substantial loss of life or human suffering or damage to , and destruction of property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area.
- The prime minister is the chairperson of the National Disaster Management Authority
- The Chief of Minister of the state is the chairperson of the State Authority

Prompt Report from the site to the authority is highly required!

2－25

TOR from World Bank to JWA

- To review the operations and maintenance methods, procedures and status of dams under Dam Rehabilitation and Improvement Project and to provide advice and guidance to improve the O&M methods from dam safety point of view. More specifically, after the general review of the present status, they will focus on providing operation and maintenance methods during/after the seismic activities, and will draft manuals and check lists of the activities needed to be performed after the seismic activities from the dam safety view points for field engineers under DRIP.

2－26

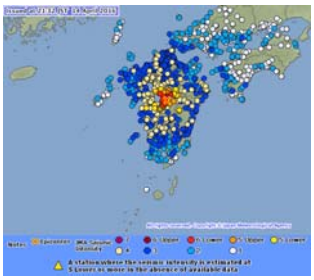
Recent Earthquake affected India

13,April 2016
Mw 6.9
PM7:25 ICT
Epicenter : Myanmar

2－27

Latest case study in Japan

Heavy Earthquake hit Southern Japan!
Last Week



Resource: Wikipedia
10:50 16,April 2016

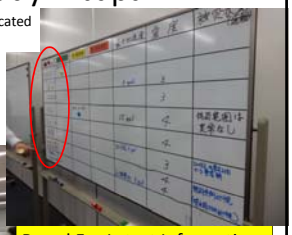
Kumamoto Earthquake
14 April 2016
PM 9:26 JST
Mw 7.0
Max JMA Seismic Intensity 7

2－28

Latest case study in Japan

JWA Faculties located Southern Japan

The officials in charge were mobilized
To Emergency Headquarter
Due to the information of Mobile phone

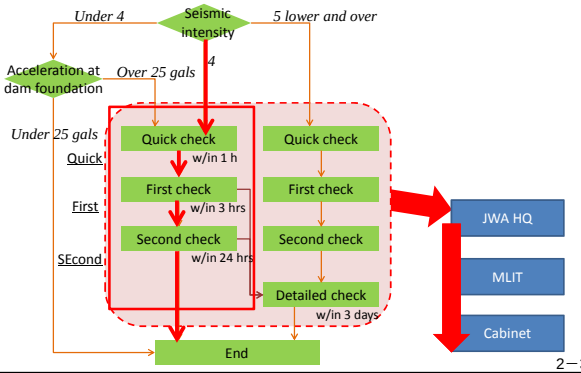


Board For Latest Information
Max JMA Seismic Intensity: 4
Status : no issue

Photo Emergency Headquarter at PM10:30 14 April 2016

2－29

Extraordinary inspection aftermath of great earthquake



2－30

Conclusion

- From the point of view of disaster management ,the prompt situation report is highly required.
- To establish urgent reporting system, developed inspection system is also highly required in India.

The first Consultation Meeting,20-22 April,2016

Outline of Dam Safety Management

20 April, 2016

Kentaro KIDO Ph.D.
Director, Dam Engineering Division,
Water Resources Engineering department,
Japan Water Agency

trust funded and administrated by THE WORLD BANK

Contents

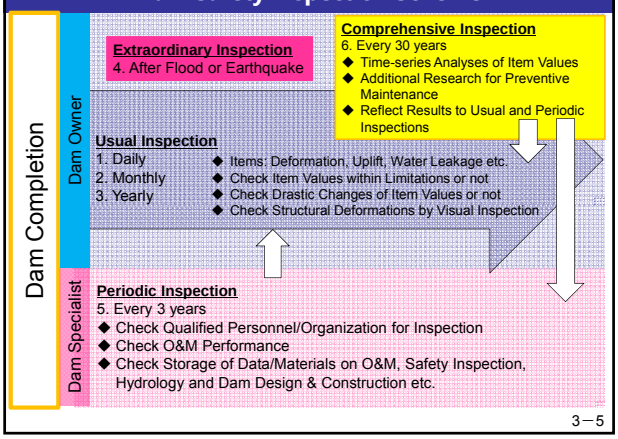
1. Dam Safety Inspection in Japan

Dam Safety Inspection Scheme

Dam Safety Inspection in Japan

- **Inspection by Dam Owner**
  - **Usual Inspection**
    - Daily
    - Monthly
    - Yearly
  - **Extraordinary Inspection**
    - After flood hit
    - After earthquake occurred
  - **Comprehensive Inspection**
    - Every 30 years
- **Inspection by External Specialist**
  - **Periodic Inspection**
    - Every 3 years

Dam Safety Inspection Scheme



Inspection Items for Each Dam Type

Article 13 of Cabinet Order concerning Structural Standards for River Management Facilities, etc.

Dam type		Height	Inspection item
Concrete Gravity Dam		Less than 50 m	Leakage, Uplift
		50 m or more	Leakage, Uplift, Deformation
Concrete Arch Dam		Less than 30 m	Leakage, Deformation
		30 m or more	Leakage, Deformation, Uplift,
Embankment Dam	Uniform type		Seepage, Deformation, Saturated line
	Zone type		Seepage, Deformation

Standard for Inspection Items and Frequencies

Management Category		Dam type	Inspection Items and Frequencies			
			Leakage Seepage	Uplift	Deformation	Patrol
1st period	Test submerging	Concrete dam	Once a day	Once a day	Once a day	Once a day
		Embankment dam			Once a week	
2nd period	At least 3 years after the 1st period	Concrete dam	Once a week	Once a week	Once a week	Once a week
		Embankment dam			Once a month	
3rd period	After the 2nd period	Concrete dam	Once a month	Once a month	Once a month	Once a month
		Embankment dam			Once in three months	

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Measurements of Dam Safety Evaluations

Evaluation Point;

- Type of the changes of dam behavior as time proceeds
- Correlation with water level, ambient temperature, rainfall, etc.
- Peculiar behavior in overall data
- Difference compared to other dams' behavior

3－8

Measurements of Dam Safety Evaluations

Type of the changes of dam behavior as time proceeds

(a)	δ	Under a constant load condition, the measured value decreases with time.	Infiltration amount Stable
(a')	δ	Under a constant load condition, the measured value remains constant with time.	Osmotic pressure Stable
(b)	δ, t	Under a constant load condition, the measured value increases with time, but the increase rate decreases with time.	Settlement Horizontal deformation Stable
(c)	δ	Under a constant load condition, the measured value increases with time at a constant rate.	Cautious
(d)	δ	Under a constant load condition, the measured value increases with time at an increasing rate.	Dangerous

Stable

Dangerous

3－9

2. Measurements of Dam and Safety Evaluations

3－10

Safety Evaluation of Dam

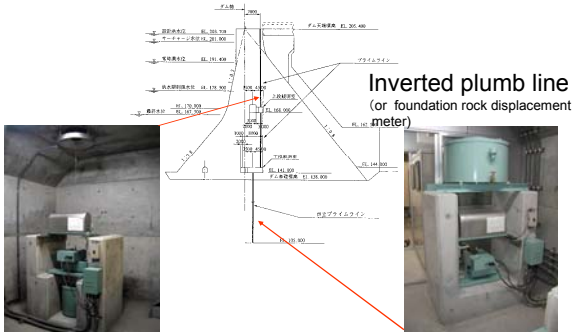
Main evaluation items

by monitoring data;
- •Deformation of dam body
- •Leakage/Seepage from dam body and foundation
- •Uplift pressure under dam body (*Concrete dam)

by visual observation ;
- •Deformation of surface of dam body (*Fill type dam)
- •Deformation of abutment slope
- •Deterioration of concrete; cracking, ageing, etc.
- •Leakage/Seepage from dam body and foundation

3－11

Deformation of Concrete Dam

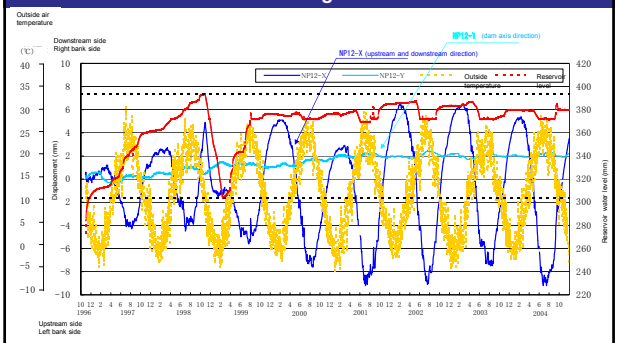


Inverted plumb line (or foundation rock displacement meter)

Normal plumb line (or dam deflection meter)

3－12

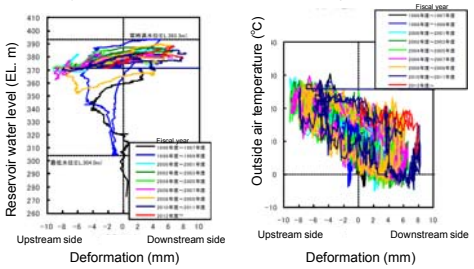
Deformation of Concrete Dam – An example of secular change



3－13

Deformation of Concrete Dam - An Example of Correlation Diagram

Relationship between X (Deformation in the direction of upstream and downstream) and reservoir water level/ ambient temperature



Decrease in reservoir water level/ Rise in temperature
→ Displacement of dam body in the direction of upstream side

3－14

Points to Make on Deformation Measurement

1) Maintenance of plumb line
- Oil becomes sticky because of aging.
- Periodical quality check and replacement of oil are required.

Oil tank of Plumb line

2) Securing continuity of measurement data when replacing equipment
- When there is a position gap between before and after the replacement, the cumulative displacement amount becomes unclear.
- Record the measured values just before the replacement
- replace the equipment promptly before deformation of the dam body occurs.
- Record the fact that replacement was implemented.

3) Periodical manual measurement
- Manual measurement is effective for the check of automatic measurement data

3－15

Leakage from concrete dam body / foundation

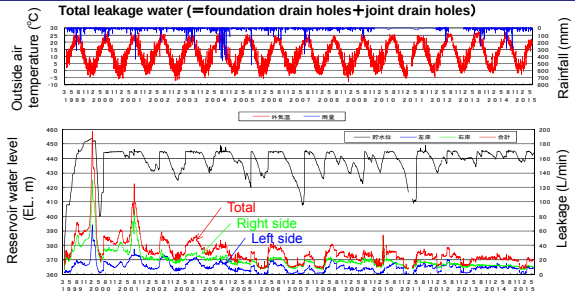
Foundation drain hole

Joint drain hole

Triangular weir

3－16

An Example: Leakage Water Secular Time



○Year to year tendency: gradually decreasing in general（Clogging on the leakage path）

○Reservoir water level rise → Leakage volume increase

○Ambient temperature (dam body temp.) drop → Leakage volume increase

3－17

Evaluation Methods and Attention Points of Leakage

(1) Secular change of leakage
- ○ Check incomprehensible measurements such as sudden data changes, mistakes of gauging, and data transcription errors etc.
- ○ Verify daily and seasonal variation

(2) Correlation between reservoir water level and leakage, (esp. foundation drainage.)
- ○ Any abnormal correlation between drainage and reservoir water level ?
- ○ Measurements contained within the past range of ones at test filling time ?

(3) Correlation between ambient temperature and leakage, (esp. joint drainage)
- ○ Leakage increased in winter season returns to original volume with increase of ambient temperature ?
- ○ Leakage increases only in winter season ? It remains within past records ?

(4) Leakage is turbid or not

3－18

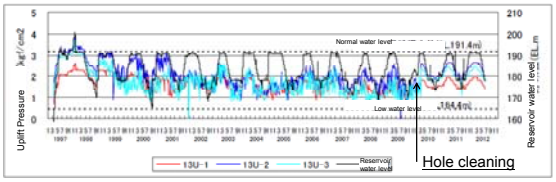
Uplift Pressure

Bourdon pressure gauge

Pore pressure meter*

*Embedded meter tend to lose measuring capability after 20 years .

An Example of Measurement Result of Uplift Pressure



- Uplift pressure tends to drop with the passage of time
- Uplift pressure tends to up after 2010.
- It was caused by cleaning of foundation drain holes.

Deterioration of Concrete

Leakage through dam body

Alkali-Silica Reaction

Drying shrinkage / Thermal crack

Crack by large-scale earthquake

Frost attack

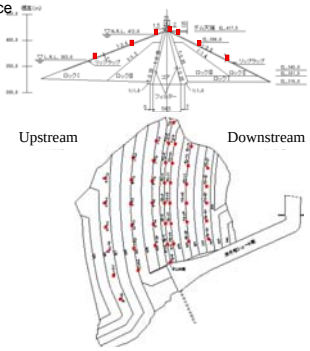
Abrasion

Deformation of Rockfill Dam

External Deformation and its Measurement Method

- Targets are installed on the surface of dam body.
  - Dam crest, upstream and downstream surfaces.
- Targets are surveyed.
  - The up-and-down stream direction for horizontal deformation
  - The dam axis direction for horizontal deformation
  - The vertical direction for settlement

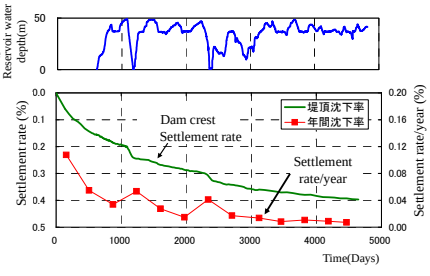
Targets of downstream surface



Deformation of Rockfill Dam

External Deformation (Vertical)

- The settlement rate is rather large just after the embankment works completed. The settlement tends to decline.
- The final settlement rate is about 0.4%.
- The annual settlement rate is about 0.01% and can be seen constant.

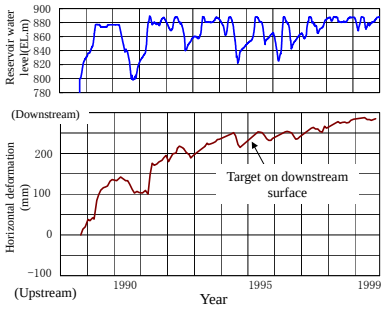


Settlement rate = Dam crest settlement / Dam height

Deformation of Rockfill Dam

External Deformation (Horizontal)

- The dam body deforms toward downstream direction as the reservoir is impounded.
- The dam body deforms toward upstream direction as the reservoir level draws down.
- The accumulated deformation toward downstream direction is gradually stable year by year.

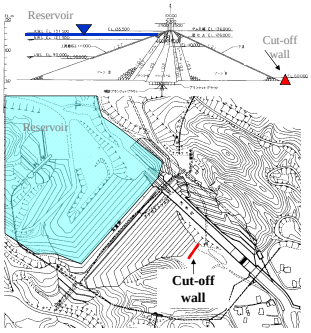


Seepage from Rockfill Dam Body / Foundation

Seepage

- The seepage amount is measured at the downstream edge of the dam body.
- Seepage water is dammed up by cut-off wall.
- A flow rate is automatically measured by a triangular weir.
- This measuring method is affected by the rainfall in the rock zone.

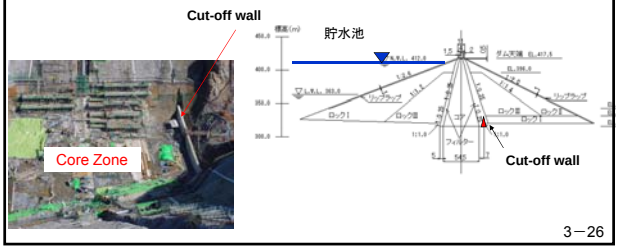
Triangular weir



Seepage from Rockfill Dam Body / Foundation

Seepage

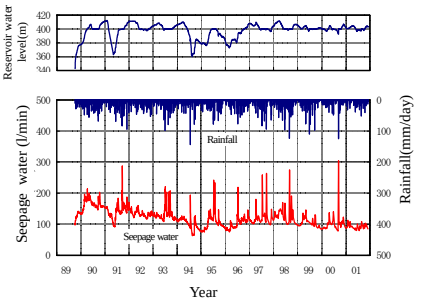
- Install cut-off wall on downstream of filter zone
- Remove rainfall volume on downstream of rock zone from seepage



4. Measurements of Rockfill Dam and Safety Evaluations

Seepage

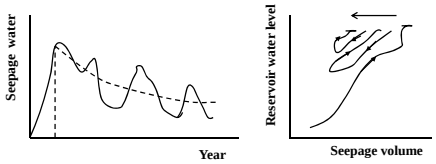
- The seepage volume is decreasing and becomes constant with the passage of time.
- The seepage volume changes as the reservoir water level changes.
- The seepage volume increases temporarily during the rainfall, and it decreases after the rainfall.



Seepage from Rockfill Dam Body / Foundation

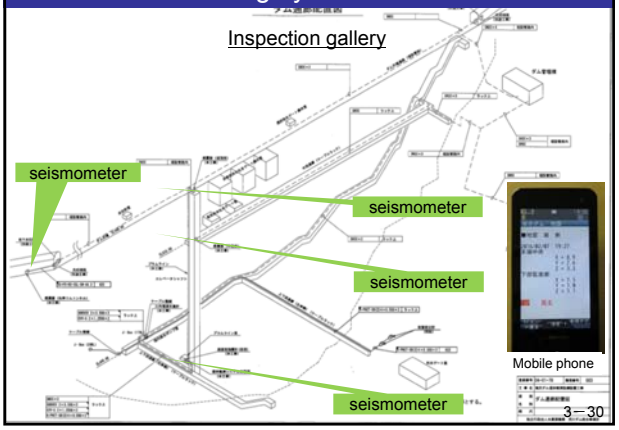
Seepage

- The seepage volume decreases year by year at the time when the effect of rainfall is small, corresponding to nearly the same water level of the reservoir.
- Trend of the changes with the passage of time is (a) →Steady trend



3. Evaluation of Impact by Earthquake

Monitoring by Seismometer



Extraordinary Inspection Immediately after an Earthquake

- Extraordinary inspection upon an earthquake
  - −No.1 alert formation: Intensity 4, or 25 cm/s^2 or more at the dam foundation
  - −No. 2 alert formation: Intensity 5, or 80 cm/s^2 or more at the dam foundation
- 1st inspection report : to be made within 3 hrs
- 2nd inspection report: to be made within 24 hrs（including quick report of inspection, leakage/Seepage, deformation etc.）

Damage condition at the management office after the earthquake

Display of seismometer

3－31

Alert level defined in the disaster prevention plan

	Flood	Water quality (e.g. oil leakage)	Earthquake
Caution	Path of typhoon, Rainfall forecast	Accident Information	----------
Alert level 1	Path of typhoon, Rainfall forecast	Action needed	Intensity 4 or 25 gals at dam or minor damage
Alert level 2	Flood control needed	Further action needed	Intensity 5 or From 80 to 250 gals or Substantial damage
Emergency	Over the design flood	Affect to water supply	Intensity 6 or Over 250 gals or Critical damage

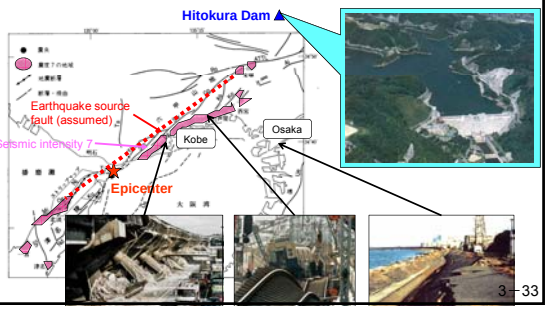
地震計の表示

All of staff members need;
To inform the safety of his/her own,
To come to office without waiting for an order, and
To start checking process.

3－32

Safety Evaluation of Dams after Earthquake - Hyogoken-Nambu (Kobe) Earthquake (1995)

- ✓ Mw=6.9 (Ml=7.2)
- ✓ Hitokura Dam (JWA, Gravity, H=75m)
  - Situated 47 km from the epicenter
  - Max. acceleration at dam base=183 cm/s^2 (upstream/downstream)



3－33

Safety Evaluation of Dams after Earthquake - Hyogoken-Nambu (Kobe) Earthquake (1995)

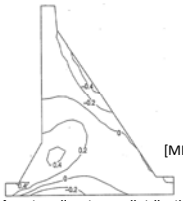
Actions taken at Hitokura Dam

Inspection of the dam body immediately after the earthquake

➢*No damage in the dam body and facilities*

Analytical evaluation by dynamic analysis using observed seismic waves

➢*Maximum tensile stress in the dam body was estimated to be small enough*



Max. tensile stress distribution by dynamic analysis

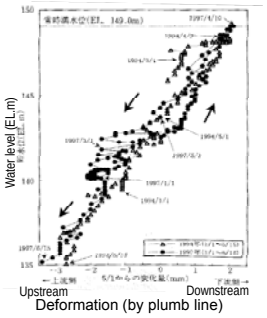
The reservoir level at the earthquake was down and the depth was only 55 % of normal water level.

Detail monitoring until reaching the high water level after the earthquake to confirm the safety of the dam and foundation rock

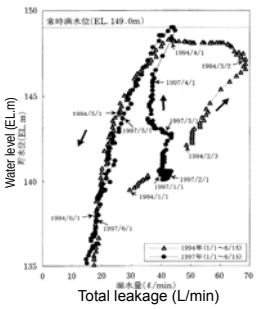
3－34

Safety Evaluation of Dams after Earthquake - Hyogoken-Nambu (Kobe) Earthquake (1995)

➢ *Behavior of the dam body after the earthquake showed same trend as that of before the earthquake.*



Deformation (by plumb line)

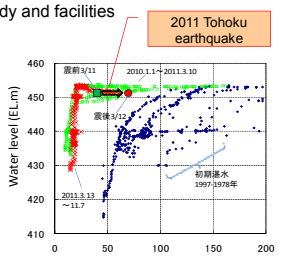


Total leakage (L/min)

3－35

Safety Evaluation of Dams after Earthquake - Great East Japan (Tohoku) Earthquake (2011)

- ✓ Mw=9.0
- ✓ Kusaki Dam (JWA, Gravity, H=140m)
  - Situated 354 km from the epicenter
  - Max. acceleration of dam base=77 cm^2/s (upstream/downstream)
  - No damage in the dam body and facilities



Change of leakage before/after earthquake

3－36

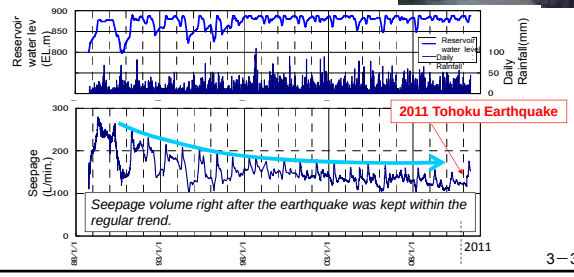
Safety Evaluation of Dams after Earthquake
- Great East Japan (Tohoku) Earthquake (2011)

✓ Naramata Dam (JWA, Rockfill, H=158m)

Max. acceleration of dam base=7 cm²/s
(upstream/downstream)

No damage in the dam body and facilities

Increase of Seepage 116→141liter/min

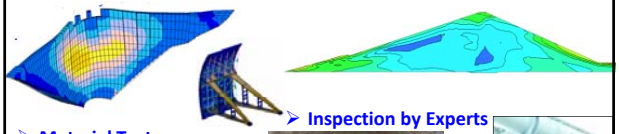


3－37

Advanced Technologies for Dam Safety

✓ JWA has its own Engineering Center and many engineers with excellent skills and experiences for evaluating and increasing safety of dams.

➢ **2D/3D Dynamic Analysis for MCE**



➢ **Material Test**

➢ **Inspection by Experts**

3－38

Advanced Technologies for Dam Safety

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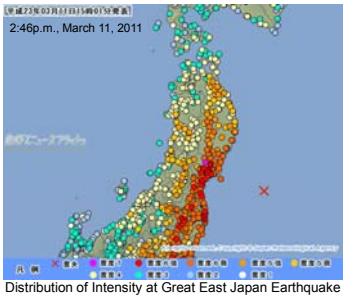


Distribution of Intensity at Great East Japan Earthquake

Thank you for your attention.

3－40

The first Consultation Meeting,20-22 April,2016

Management Policy on Electric, Information, Telecommunication and Mechanical Facilities for Dam O&M

20 April, 2016

Masahiro Sugiura, Ph.D.
Deputy Director, International Affairs Division,
Water Resources Engineering department,
Japan Water Agency

trust funded and administrated by

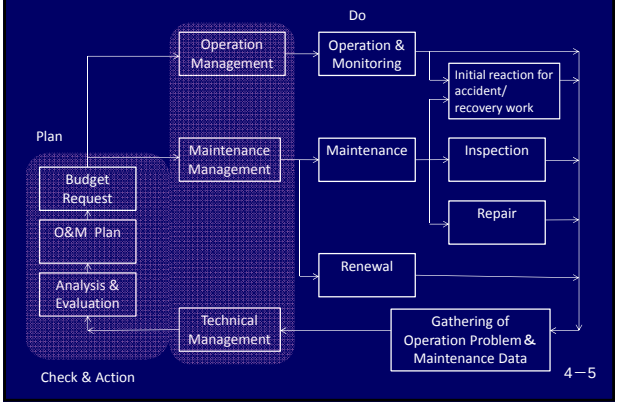
Contents

1. Concept of Facility Management

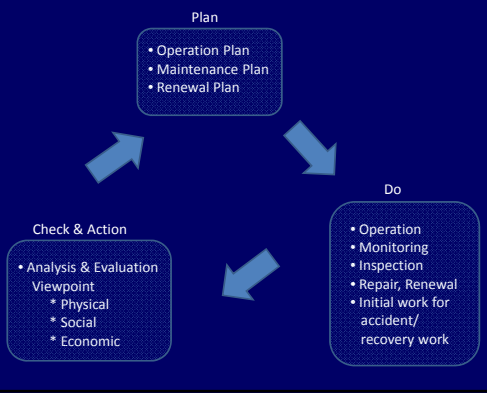
Basic Concept:

Safety and Reliability
in
Consideration of Economy

2. System of Facility Management and PDCA Cycle
System of Facility Management



2. System of Facility Management and PDCA Cycle
PDCA Cycle



3. Level of Facility Management

What is a level of Facility Management?

How to decide a level of Facility Management?

3. Level of Facility Management

Case of JWA, Requested operating ratio (A, B, C)

A : 100% (nonstop)
B : 99.7% or more(outage term : under 1day/year)
C : under 99.7% (outage term : 1day/year or more)

* without inspection term

A : Electric power receiving and transforming facility, Telecommunication facility (Water level gauge)
B : Monitor camera
C : Meteorological observation facility

A : Water level gauge
B : Water flow gauge
C : Rainfall gauge, Earthquake gauge, Water quality gauge

4. Facility Management Practices

Gathering of Operation Problem & Maintenance Data

Analysis & Evaluation Viewpoint
* Physical
* Social
* Economic

4. Facility Management Practices

Gathering of Operation Problem & Maintenance Data — Purpose — Analysis & Evaluation Developing O&M Plan System Design

Operation Problem
* Operation record (switch, gate, alarm etc)
* Requested matters by Operator (good/bad operability etc)

Maintenance Data
* Results of inspection
* Repair record
* Comment by Maintenance Personnel

Basic Data
* Inventory book on Facility
Installation purpose, date and place, Specification, Repair record, Renewal plan
* Inventory book on Spare parts
Parts name, Model number, Manufacturer, Amount, Price, Storage place
* Failure history
Facility name and place, Date, Failure condition, Reason and repair

4. Facility Management Practices

Check & Action

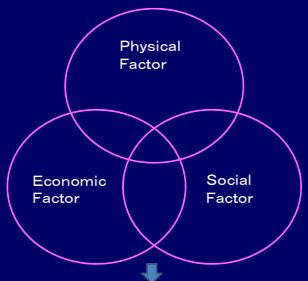
• Analysis & Evaluation Viewpoint
* Physical
* Social
* Economic

Physical Factor
* Aising
* Out of spare parts stock
* Trouble of electric element

Social Factor
* Technology obsolescence
* Changing regulation
* Social needs (noise, odor etc.)

Economic Factor
* Operation cost
* Maintenance cost
* Asset value

Analysis & Evaluation on Facility Condition



Considering the points of Enhancement/Improvement

Considering the O&M Plan

4. Facility Management Practices

Engineering Capabilities — Purpose — Coordination for sustainable facility management

Operation management
* Developing Manual for Daily operation and Initial reaction for accident
* Technical guidance to successor

Maintenance management
* Developing Manual for Maintenance and Initial reaction for recovery work
* Technical guidance to successor

Technical Management
* Analysis and Evaluation of result of inspection
Performance, Reliability, Maintainability, Life cycle cost, Technology selection, System design
* Developing Plan
Review of O&M, Developing O&M plan

5. Maintenance and Renewal Period of Facility

What is the Maintenance and Renewal Period?

Case of Telemetric Equipment

Target (for example)

* Supervisory and Control Equipment
* Telemetry Equipment
* Rainfall Gauge Equipment
* Water-level Gauge Equipment
* DC Power Supply Equipment
* Station House

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5. Maintenance Period of Facility

What is the Maintenance Period?

Case of Telemetric Equipment

Daily Maintenance : Lamp test
Voltage check
Printed observational data check

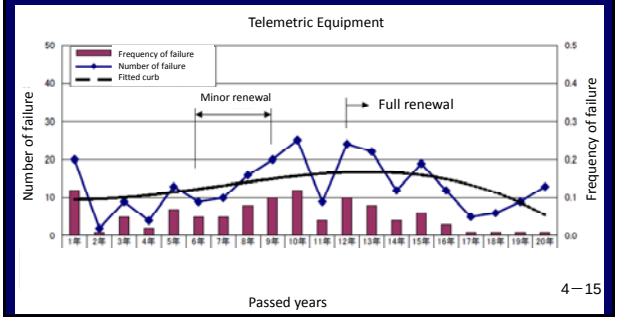
6-month Maintenance : Equipment condition check
System condition check
Adjustment or repair, if necessary

Yearly Maintenance : Overall system condition check
If any defect is found, restore them before rainy season.

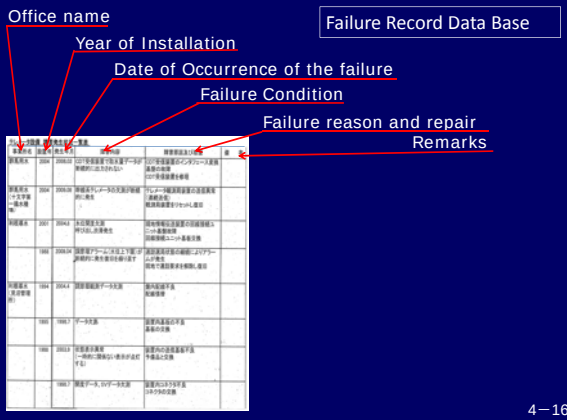
4－14

5. Maintenance Period of Facility

What is the Renewal Period?
How to decide the Renewal Period?



4－15



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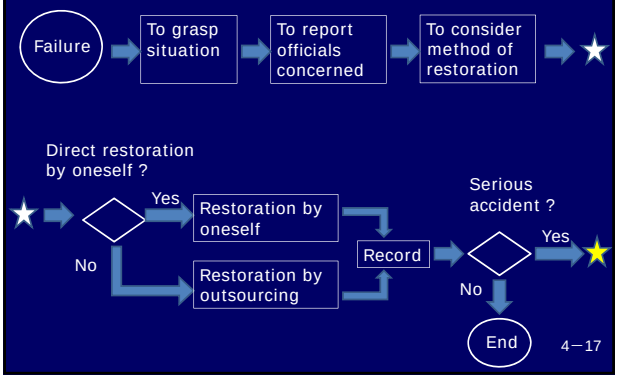
6. Failure Response



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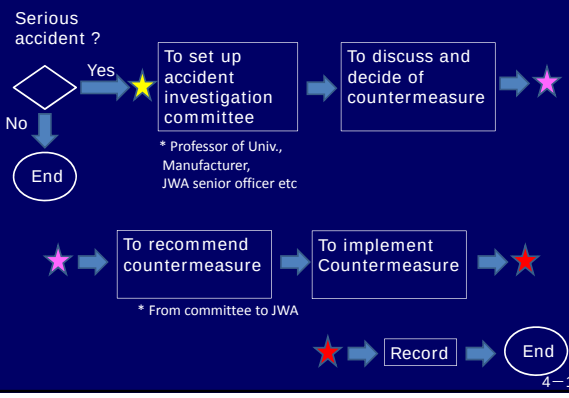
6. Failure Response
Accident investigation committee



4－18

Precondition

* There are service technician for inspection.

* There are spare parts.

* There are budget for maintenance.

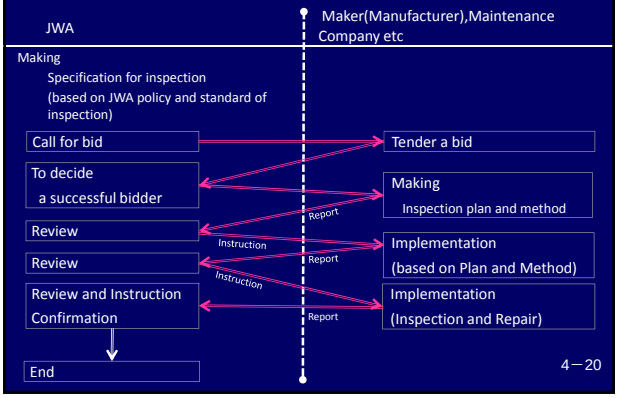
To choose and use domestic production.

* If you do not select domestic production……
To select a vendor with service technicians in Indonesia.

* If there are not budget for maintenance……
To have to think about income mechanism
for maintenance.
Cf. Electric generation, Beneficiary contribution
through local gov, etc.

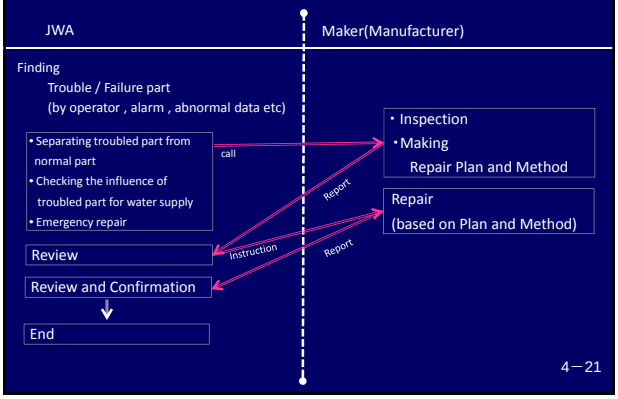
4－19

Implementation Process of inspection in the field.
ex . High voltage substation facility , Pump facility etc.



4－20

Emergency repair Process of Electrical and Mechanical Facilities in the field.
ex . High voltage substation facility , Pump facility etc.



4－21

Masahiro Sugiura, Ph.D.

1991-
* Ministry of Construction,
* Kinki Regional Construction Bureau
* Public Work Research Institute
* Water Resources Development Public Cooperation
* Japan Water Agency
* JICA Expert in Sabo Technical Center in Indonesia (2001-2004)

Including
Design, construction and budget Management, O&M, Research on Water Resources Facilities

- Last 5 years –
2010 Commissioned Engineer,
Public Enterprise Bureau,
Saitama Prefectural Government
2012 Director for Water Control System,
Chiba Regional Water Control and Management Office,
Japan Water Agency
2015 Deputy Director,
Water Resources Engineering Department,
Japan Water Agency

4－22

The first Consultation Meeting,20-22 April,2016

Outline of the Checklist and the Inspection Manual after the Seismic Events

20 April, 2016

Nobuyuki Ichihara
Deputy Director, International Affairs Division,
Water Resources Engineering department,
Japan Water Agency

trust funded and administrated by

Contents

1. Outline of the Checklist of JWA
2. Outline of the Inspection Manual of JWA
3. Procidure to draft the Checklist and the Inspection Manual

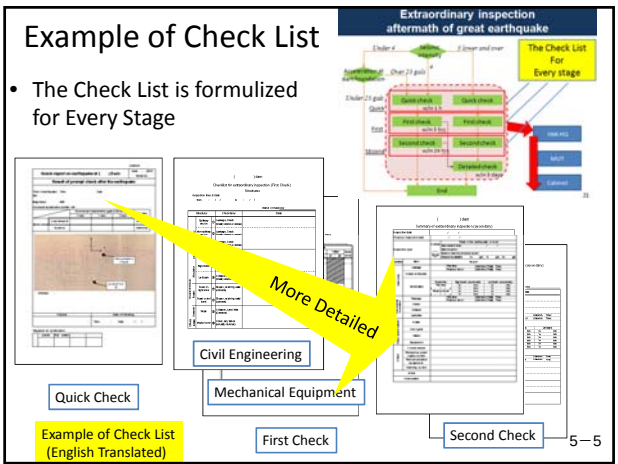
1. Outline of the Check list of JWA

The contents of the Check List

- The Check lists are required to be prepared for every stages , Quick Check (within1h),First Check(within 3h), Second within 24h.
- The items of Check List are required to be selected following the level of importance of function.

Example of Check List

- The Check List is formulized for Every Stage



Example of Check List (English Translated)

2. Outline of the Inspection Manual of JWA

The Inspection Manual of JWA

- In order to cover the difficulty of the access of the technical parson in winter season, the Inspection manual was formulized in 2006
- Up to now , this formula was widly spread in JWA's facilities

5－7

The principle of the inspection manual

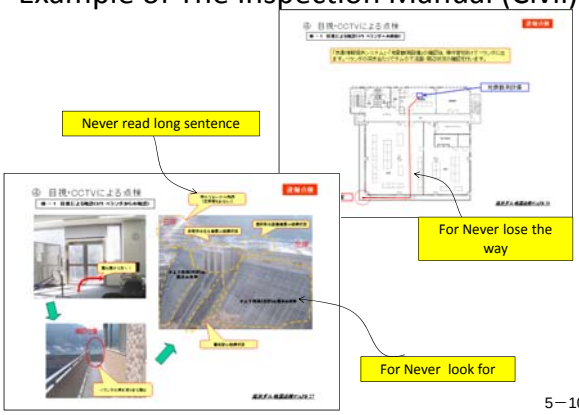
- Never lose the way
  Where you should stand!
  What is the priority?
- Never look for
  What you should see!
  Manual to be visible and handy
- Never read long sentence
  Requested to understand immediately.
  Manual to be written easily and visually

5－8

The Example the Inspection Manual of JWA

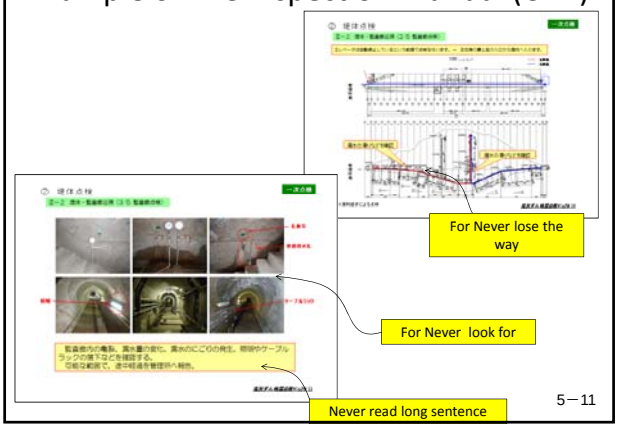
5－9

Example of The Inspection Manual (Civil)



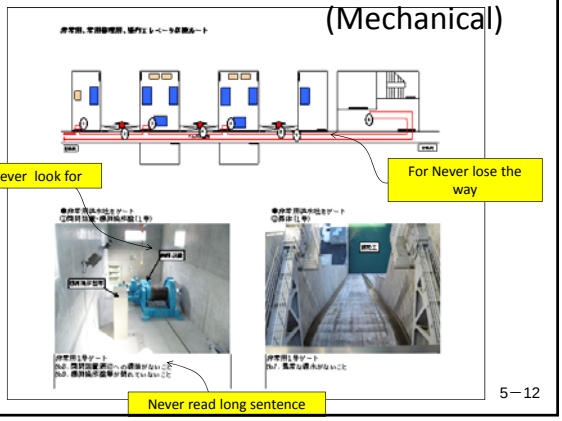
5－10

Example of The Inspection Manual (Civil)



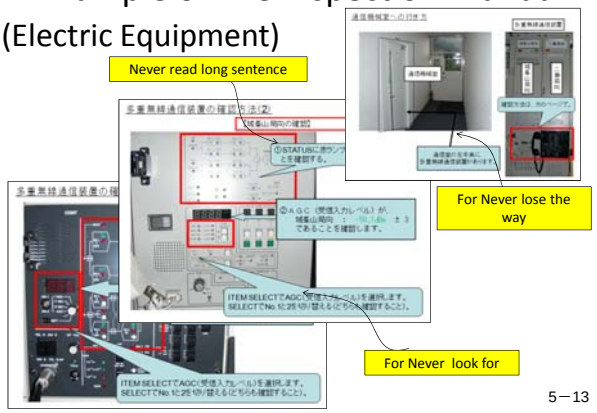
5－11

Example of The Inspection Manual (Mechanical)



5－12

Example of The Inspection Manual (Electric Equipment)



5－13

3.Procidure to draft the Checklist and the Inspection Manual

5－14

Before taking action to draft the Checklist and Manual

- We must clarify the meaning of the drafting of the Check List and the Inspection Manual
- Why? :Regal Order? Volunteer ?
- When? : Urgently ? Until Tomorrow ? Annually?
- How ? : By e-mail? Telephone? Fax
- (to) Whom? : We must develop The information flow to Authority

5－15

To draft Checklist

To draft the Checklist,
Following topics should be considered,

- The soundness of Dam Safety :
  The inspection items regarding Dam Safety
- The soundness of Gate Operation :
  The function to discharge water to reduce the water level

5－16

To draft the Inspection Manual

- The Manual should be formulized by technical personnel by considering the use of non-specialized person.
- So The principle of the inspection manual is required.
  - Never lose the way
  - Never look for
  - Never read long sentence

5－17

Thank you for your attention

- *Let's go to the site survey to establish the tailored Checklist and Manual togather!*

grouping
Civil Eng. group
Mechanical Eng. group
Electric Eng. group
Please do not forget Field book and Camera

5－18

The Consultation Meeting for the Preparation of Inspection Manual for Dam Field Engineers after the Seismic Events

22 April, 2016

Japan Water Agency

at Ichari Dam,UJVNL, Uttarakhand State

Agenda

10:00-10:15 Summary of Consultation Meeting
10:15-10:45 Outcome of Group Discussion
- Civil Engineering Group
- Mechanical Engineering Group
- Electrical Engineering Group

10:45-11:00 Recommendation by Japan Water Agency team
11:00- 11:15 Remarks
by Dr. Umakant Panwar, Principal Secretary
Department of Energy , Govt. of Uttarakhand Srate

11:15-11:30 Coffee Break
11:30-11:40 Introduction of Next Visit
11:40-11:45 Closing Remarks
by Dr.by Kentaro Kido, Director Dam engineer Division , JWA
11:45-12：00 Closing Remarks
by Mr. S N Verma, Managing Director UJVN Limited

Summary of The first Consultation Meeting

22 April, 2016

Nobuyuki ICHIHARA
Director, International Affairs Division,
Water Resources Engineering department,
Japan Water Agency

Contents

1. Background of TOR

- 1st Exposure visit:15th -17th Jun.2015
  - A.B.Pandaya former Chairman, Central Water Commission and Other total 4person
- 2nd Exposure visit:29th 30th Sep.2015
  - CWC , States, total 9person
- 3rd Exposure visit:24th -26th Nov.2015
  - CWC , States, total 8person
- 4th Exposure visit:8th 9th Mar.2016
  - CWC, Uttarakhand State etc. total 4person

4th Exposure visit

- Meeting at JWA-HQ (8 Mar. 2016)
- Visit to Takizawa Dam and Urayama Dam (JWA) (9 Mar. 2016)

・Purpose : Observe how the response is made to an earthquake and view a selective intake facility

1－7

Roundtable on Dam Safety and Management related to Seismic Hazards and Sedimentation

(11st ,March 2016 at Tokyo Office of World Bank)

Dr. Umakant Panwar, Principal Secretary of Department of Energy,Govt of Uttarakhand, became to sensitize the importance of the maintenance of the Dam Safety and the Necessity of the training for the enhancement of the capacity of Dam safety

1－8

You can watch the meeting by Internet

https://www.youtube.com/watch?v=JxLNiwWHV-8&list=PLlxZ8h0dxpsBl3M_3__8XJE5vynJkuaOV&index=4

TOR from World Bank to JWA

- To review the operations and maintenance methods, procedures and status of dams under Dam Rehabilitation and Improvement Project and to provide advice and guidance to improve the O&M methods from dam safety point of view. More specifically, after the general review of the present status, they will focus on providing operation and maintenance methods during/after the seismic activities, and will draft manuals and check lists of the activities needed to be performed after the seismic activities from the dam safety view points for field engineers under DRIP.

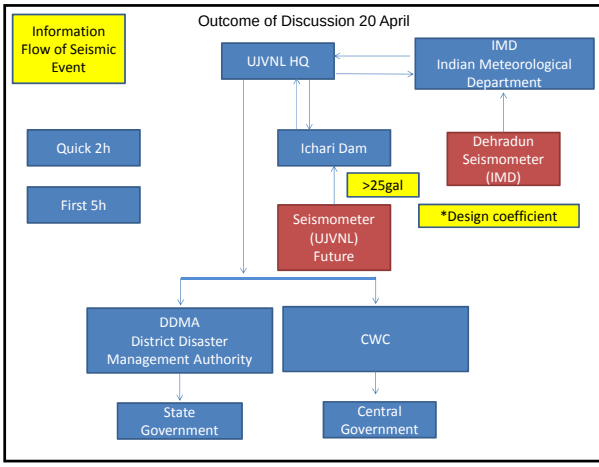
2. Flash Back of Site Survey and the Consultation Meeting

1－

Site Survey on 19 April

The Consultation Meeting on 20th April

After Opening Remarks from Shiri S N Verma and Shiri B C Misha
JWA team make presentation regarding the organization , Disaster management
In Japan , Dam Safety, Maintenance of Equipment
and Check List and Inspection Manual.
To establish the check list , we discuss the information flow regarding the response of Seismic Event



The Consultation Meeting on 21 April

On 21 April, After grouping for Civil Engineer ,Mechanical Engineer
and Electric Engineer, Each group made a Group discussion to draft check list.
After noon, Each group move to site survey to revise the draft check list and take Photo for drafting manuals

Draft check List will be introduced by Group Leader

Site Survey on 21 April

Thank you for your attention

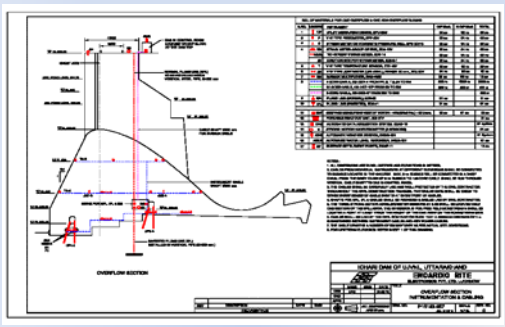
on 19th April at Haridwar

SALIENT FEATURES OF ICHARI DAM

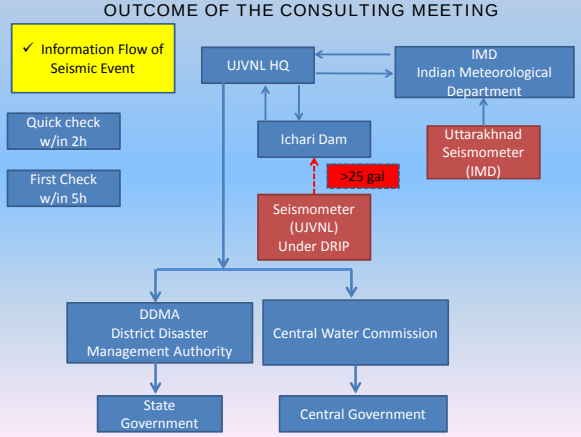
Type of Dam	59 m high Concrete straight gravity
River	Tons
Catchment Area	4890 SqKm
Design Flood	13500 cumecs
Headrace Tunnel Dia & Length	7.0 m circular dia & 6.2 km in length
No. & size of spillway gates	7 Nos. & each of 9.5 m (B) X 16.5 m (H)
Installed Capacity of Chibro Power House	240 MW

OUTCOME OF THE CONSULTING MEETING

✓ Installation of instruments



OUTCOME OF THE CONSULTING MEETING



OUTCOME OF THE CONSULTING MEETING

✓ Preparation of quick checklist of specialized sector i.e Civil Engineering, Mechanical Engineering, Electrical Engineering.

Quick Checklist for Civil Engineering aspect :-

Sl.No	Structures	Check Item	
1	Dam Structure		
a)		Cracks & leakage in Spillway section , non spillway section , construction shaft & gallery	
b)		Cracks in piers , intake tower	
c)		Cracks, settlement in Bridge (5 nos)	
2	Reservoir	Any change / obstruction in flow pattern	
3	Buildings	Cracks in buildings, staff room & stores etc	
4	Slopes	Any settlement in slope within the dam premises on both banks	
5	Parapets , railings, fencing	Steadiness	

OUTCOME OF THE CONSULTING MEETING

✓ Preparation of Inspection Manual

Principle of inspection Manual:-

- Priority.
- Manual to be handy.
- Manual to be self demonstrative.


THANK YOU
ありがとう

Check Points of Mechanical equipments installed

at

Ichari Dam

Gates Opening and Closing Equipment

- Shape and Crack
- Wire Rope
- Crack or deformation
- Leakage

(1) Visual inspection of any kind of distortion in Gear-Couplings of all the motors of 07 nos. Radial gates, 02 Nos. Tunnel control gates, 01 no. Auxiliary gate and 03 nos. Flushing conduit gates.

(2) Visual inspection of any kind of distortion at the left- right & bottom sides of all the radial gates.

Operation Board

- Abnormality display

(3) Local display Panels of all the Radial Gates

Drainage Pumps

(03 Pumps are installed in Dam Inspection Gallery having capacity of 1.5, 1.5 & 1.0 cusecs)

- Proper functioning & Delivery

Elevator - Existing 15P elevator is out of order, replacement is proposed in DRIP

- Put the **Don't Use** (Sign Board)

Thank you

Checklist for Electrical and Telecommunication Equipments

Quick Checklist

For initial extraordinary inspection after earthquake in first hours

Communication System

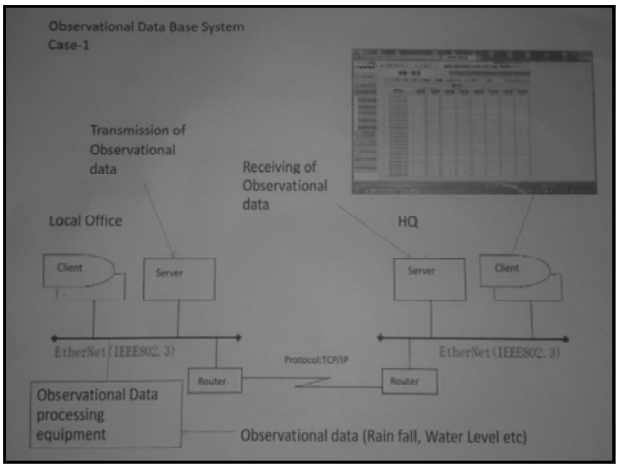
- Two mode of communication at DAM site
  - Telecommunication
  - Mobile Communication
- In case of earthquake, both mode of communication need to be checked by calling

In extraordinary situation like earthquake and severe flood both communication are non-reliable

Private Communication System

- A private communication network need to be developed connection all Dams and Barrage

JWA has installed this kind of communication tower at all Dam site



Checklist For Electrical Power Equipments

Electrical Power Equipments checks

Check for following equipments and auxiliaries

- Supply to Drainage pump – Voltage and current
- Motor drive Power panel – Visual as well as Voltage and current

Emergency Generator

Ichhari Dam has 3 Generator

- 250 KVA
- 70 KVA
- 30 KVA

Need to check the following

- Fuel
- Cooling water
- Compressor

Emergency Generator

- Ichhari Dam has 3 Generator and 400 liter of Diesel stored at dam site
- 400 liter is enough of for 15-16 hours operation in case of total power failure
- In case of catastrophic situation, 72 hours operation fuel is required which means 1800-2000 liter diesel storage

Dam control system

Dam control system

The SCADA system collect and display various data i.e.

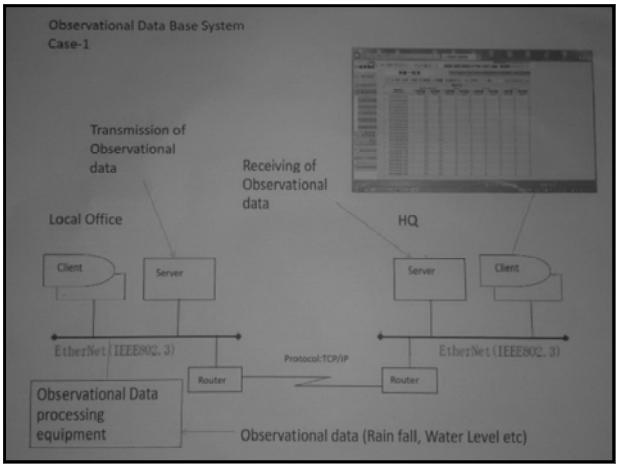
- FC gates position
- Spillway gates position
- Today max. water level
- Today min. water level
- Head loss
- water discharge to river
- Motor current of Spillway gates

•We need to check the its display panel only

Dam Observation and surveillance equipment

• The SCADA system collect and display the reservoir water level in real with the help of Ultrasonic sensor

• CCTV surveillance (Proposed in DRIP)



Final Checklist for first hour

Check Items	Kind of Check
Mobile Communication	Voice call check
Cable Communication	Voice call check
Satellite Communication	Voice call check
Power Supply equipments	Visual check, Voltage and current check
Emergency Generator	Fuel, Cooling water, Compressor
Dam control system	Visual check of Display Panel
Dam observational equipment	Visual checks of Display panel

Thank you

The first Consultation Meeting,20-22 April,2016

Recommendation

22 April, 2016

Japan Water Agency

trust funded and administrated by THE WORLD BANK

Good points

(1) To be kept the important function (such as gate control, electric supply), in spite of aging facility
: Having ability for O&M

(2) Keeping things tidy and in order
: Basics for prevention of operation mistake

Check Points

(1) Gate control, (2) Electric supply by emergency generator,
(3) Communication tool for information sharing
(4) Safety and Speedy (be careful fall down during inspection)

Recommendation

(1) Recording results of dairy inspection.
(2) Increasing fuel tank for emergency generator. 72h
(3) Securing Communication tool during disaster. Exclusive line (observational data, voice communication)

Recommendation

- Although have passed 40 years, the state of dam is considered good as a whole
- Some structure, e.g. Control tower, Crane, Bridge to flushing gate look "Top heavy" or too slender; possibility of damage by earthquake
- Measuring apparatus for evaluating the safety of the dam is insufficient
  e.g. uplift pressure gauge
  detail monitoring tool of leakage (zoning, each drain hall)
  rainfall, temperature (air, reservoir water)
- Dewatering operation is recorded, but "water volume" is not organized
  → variation with time
  correlation with reservoir water level, rainfall, temperature, etc.
- Drawings should be referenced at the time of inspection
  Photo, sketch are effective tools

Appendix 4

Questionnaires of Consultation Meeting

Water supports wealthy society
Incorporated Administrative Agency
Japan Water Agency

Japan Water Agency
11-2 Shintoshin, Chuo-ku, Saitama-city, 330-6008, JAPAN
Tel: +81-48-600-6553 Fax: +81-48-600-6509
http://www.water.go.jp/honsya/honsya/english/index.html

The Consultation Meeting for the Preparation of Inspection Manual for Dam Field Engineers after the Seismic Events

20 -22 April, 2016 , Dehradun India

CONSULTATION MEETING EVALUATION QUESTIONNAIRE

This is the first time to conduct the Consultation Meeting by adopting the style which you experienced. Your response will help us to improve the quality and ensure the continuity of similar Forums in the near future. Please fill in the following points.

Is the Consultation Meeting valuable for you?	☑ YES	☐ NO			
Please indicate the points you enjoyed.	Mainly the Site Survey (Ichari Dam)				
How do you rate the Consultation Meeting?	EXCELLENT 5 ✓	4	3	2	POOR 1
Please indicate the points you felt.	5				
What is the impressive of the Consultation Meeting?	Group Discussion and findings of the check points				
Did you understand that the prompt response is required after seismic event?	Well understood ☐	Understood ☑	Not really ☐		
Comments, if any.	It must be required				
Did you think *the Check List* is useful for practicing for seismic event?	Very useful ☐	Relatively useful ☐	Not so useful ☐		
Comments, if any.	Very Useful				

Water supports wealthy society
Incorporated Administrative Agency
Japan Water Agency

Japan Water Agency
11-2 Shintoshin, Chuo-ku, Saitama-city, 330-6008, JAPAN
Tel: +81-48-600-6553 Fax: +81-48-600-6509
http://www.water.go.jp/honsya/honsya/english/index.html

Did you understand how to use the *Inspection Manual*?	Well understood ☐	Understood ☐	Not really ☐
Comments, if any.	Understood		
Did you think *the Inspection Manual* is useful for practicing for seismic event?	Very useful ☐	Relatively useful ☐	Not so useful ☐
Comments, if any.	Very Useful		
Do you think the program of this workshop can be applied to your capacity building especially for Field Engineer ?	Applicable ☐	Relatively applicable ☐	Not applicable ☐
Comments, if any.	Applicable		

What king of instrument is required to improve the response for the Earthquakes for your facilities?	1) Seismometer 2) Wireless communication 3) Sufficient backup for Auxiliary supply for the Ichari Damsite
Any comment as you like	— NA —

Thank you very much for your understanding and cooperation.

Your Name MOHD. AFZAL

Position/Organization EE (E&M), Ichari Dam.
UJVN Ltd

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http://www.water.go.jp/honsya/honsya/english/index.html

The Consultation Meeting for the Preparation of Inspection Manual for Dam Field Engineers after the Seismic Events

20 -22 April, 2016 , Dehradun India

CONSULTATION MEETING EVALUATION QUESTIONNAIRE

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Is the Consultation Meeting valuable for you?	☑ YES	☐ NO
Please indicate the points you enjoyed.	very interactive discussion	

	EXCELLENT				POOR
How do you rate the Consultation Meeting?	5	4 ✓	3	2	1
Please indicate the points you felt.					
What is the impressive of the Consultation Meeting?	Group discussion				

Did you understand that the prompt response is required after seismic event?	Well understood ☐	Understood ☑	Not really ☐
Comments, if any.			

Did you think *the Check List* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐
Comments, if any.			

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Did you understand how to use the *Inspection Manual*?	Well understood ☑	Understood ☐	Not really ☐
Comments, if any.			
Did you think *the Inspection Manual* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐
Comments, if any.			
Do you think the program of this workshop can be applied to your capacity building especially for Field Engineer ?	Applicable ☑	Relatively applicable ☐	Not applicable ☐
Comments, if any.			

What king of instrument is required to improve the response for the Earthquakes for your facilities?	Seismometer, Communication devices, weather stations etc.
Any comment as you like	

Thank you very much for your understanding and cooperation.

Your Name Harish Dhapola

Position/Organization EE (Maneri Dam)

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Is the Consultation Meeting valuable for you?	☑ YES	☐ NO
Please indicate the points you enjoyed.	Group Discussion Mock Drill of ~~yo~~ earthquake.	

How do you rate the Consultation Meeting?	EXCELLENT 5	 4 ✓	 3	 2	POOR 1
Please indicate the points you felt.	— x —				
What is the impressive of the Consultation Meeting?	Mock Drill of earthquake.				

Did you understand that the prompt response is required after seismic event?	Well understood ☐	Understood ☑	Not really ☐
Comments, if any.			

Did you think *the Check List* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐
Comments, if any.	— x —		

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Did you understand how to use the *Inspection Manual*?	Well understood ☐	Understood ☑	Not really ☐
Comments, if any.	— x —		
Did you think *the Inspection Manual* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐
Comments, if any.	— x —		
Do you think the program of this workshop can be applied to your capacity building especially for Field Engineer ?	Applicable ☑	Relatively applicable ☐	Not applicable ☐
Comments, if any.	— x —		

What king of instrument is required to improve the response for the Earthquakes for your facilities?	Seismometer, communication system,
Any comment as you like	To prepare a effective inspection manual.

Thank you very much for your understanding and cooperation.

Your Name Abhay Singh

Position/Organization Executive Engineer (Civil)
Maneri - Bhali - I, 2
Maneri, Uttarkashi

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20 -22 April, 2016 , Dehradun India

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Is the Consultation Meeting valuable for you?			☑ YES		☐ NO
Please indicate the points you enjoyed.	• We learnt how to make safe our utility after earthquake & what instrumentation should be installed at our utility. • We learnt what to do after earthquake, how to prepare check list for any utility.				
How do you rate the Consultation Meeting?	EXCELLENT 5 ✓	4	3	2	POOR 1
Please indicate the points you felt.	As there is no checklist to meet out any emergency likewise earthquake or flood we are in position to document our checklist and manual for preventive action after earthquake if damage occurs [illegible] we will develop our standardised procedure.				
What is the impressive of the Consultation Meeting?	Very nice.				
Did you understand that the prompt response is required after seismic event?	Well understood ☑		Understood ☐		Not really ☐
Comments, if any.	Any delay in response may lead to severe damage				
Did you think *the Check List* is useful for practicing for seismic event?	Very useful ☑		Relatively useful ☐		Not so useful ☐
Comments, if any.	Yes it will be very useful.				

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Did you understand how to use the *Inspection Manual*?	Well understood ☑	Understood ☐	Not really ☐
Comments, if any.			
Did you think *the Inspection Manual* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐
Comments, if any.	Yes it will standardize the procedure.		
Do you think the program of this workshop can be applied to your capacity building especially for Field Engineer ?	Applicable ☑	Relatively applicable ☐	Not applicable ☐
Comments, if any.	Yes it can be applied to any building and Barrages also.		

What king of instrument is required to improve the response for the Earthquakes for your facilities?	⇒ Seismometer ⇒ SCADA for measuring Barrage level, gauge well level to measure velocity of stream of barrage & temperature of water at barrage. ⇒ Limit switch to limit the lift of gates at barrage ⇒
Any comment as you like	The seminar was very informative & it will be fruitful for our utilities for implementation of check list & manual & standardize the procedure for safety of dam and barrage.

Thank you very much for your understanding and cooperation.

Your Name RAJKUMAR

Position/Organization Executive Engineer (E&M)
UJVN Limited, Pashulok Barrage, Rishikesh

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Is the Consultation Meeting valuable for you?	☑ YES	☐ NO			
Please indicate the points you enjoyed.	"Mock drill"				
How do you rate the Consultation Meeting?	EXCELLENT 5 ✓	4	3	2	POOR 1
Please indicate the points you felt.	Requirement of seismometer.				
What is the impressive of the Consultation Meeting?	On site meeting was a impressive part of meeting.				
Did you understand that the prompt response is required after seismic event?	Well understood ☑	Understood ☐	Not really ☐		
Comments, if any.	A systematic Planing to encounter such situations.				
Did you think *the Check List* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐		
Comments, if any.	check list will serve a organized checking and would eliminate chancage of ommisions & mistakes.				

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Did you understand how to use the *Inspection Manual*?	Well understood ☐	Understood ☑	Not really ☐
Comments, if any.	—		
Did you think *the Inspection Manual* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐
Comments, if any.	Communication system should be addressed more.		
Do you think the program of this workshop can be applied to your capacity building especially for Field Engineer ?	Applicable ☑	Relatively applicable ☐	Not applicable ☐
Comments, if any.	—		

What king of instrument is required to improve the response for the Earthquakes for your facilities?	i) Installation of seismometer at dam sites ii) Proper communication system.
Any comment as you like	A Ton of thanks.

Thank you very much for your understanding and cooperation.

Your Name VINOD BHAKUNI

Position/Organization EXECUTIVE ENGINEER (CIVIL)
UJVNL,
UTTARAKHAND, INDIA.

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Is the Consultation Meeting valuable for you?	☑ YES	☐ NO			
Please indicate the points you enjoyed.	1. Tips given during site visit for quick check after earthquake. 2. Informative Presentations.				
How do you rate the Consultation Meeting?	EXCELLENT 5	☑ 4	3	2	POOR 1
Please indicate the points you felt.	The meeting is very helpful for quick restoration of our sites (Dams) after earthquake.				
What is the impressive of the Consultation Meeting?					
Did you understand that the prompt response is required after seismic event?	Well understood ☑	Understood ☐	Not really ☐		
Comments, if any.					
Did you think *the Check List* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐		
Comments, if any.					

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Did you understand how to use the *Inspection Manual*?	Well understood ☐	Understood ☑	Not really ☐
Comments, if any.			
Did you think *the Inspection Manual* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐
Comments, if any.			
Do you think the program of this workshop can be applied to your capacity building especially for Field Engineer ?	Applicable ☑	Relatively applicable ☐	Not applicable ☐
Comments, if any.			

What king of instrument is required to improve the response for the Earthquakes for your facilities?	SCADA DATA TO BE TRANSMITTED THROUG DEDICATED MODE. LIKE VSAT
Any comment as you like	

Thank you very much for your understanding and cooperation.

Your Name Rajesh Kumar

Position/Organization Executive Engineer (Control Room) UJVNL

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Is the Consultation Meeting valuable for you?			☑ YES		☐ NO
Please indicate the points you enjoyed.	Electric Checks Mechanical check Telecommunication check and System				
How do you rate the Consultation Meeting?	EXCELLENT 5		4	3	2	POOR 1
Please indicate the points you felt.	UJVNL lags in reliable communication system.				
What is the impressive of the Consultation Meeting?	Professional and knowledgable behaviour of JWA delegates				
Did you understand that the prompt response is required after seismic event?	Well understood ☑		Understood ☐		Not really ☐
Comments, if any.	Need to be modify as per Indian scenario				
Did you think *the Check List* is useful for practicing for seismic event?	Very useful ☑		Relatively useful ☐		Not so useful ☐
Comments, if any.					

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Did you understand how to use the *Inspection Manual*?	Well understood ☑	Understood ☐	Not really ☐
Comments, if any.			
Did you think *the Inspection Manual* is useful for practicing for seismic event?	Very useful ☐	Relatively useful ☑	Not so useful ☐
Comments, if any.	Manual need to be redesign as per Indian seismic activities and government and public response as well as Engineer response.		
Do you think the program of this workshop can be applied to your capacity building especially for Field Engineer ?	Applicable ☑	Relatively applicable ☐	Not applicable ☐
Comments, if any.	Very good.		

What king of instrument is required to improve the response for the Earthquakes for your facilities?	1. Seismometer 2. CCTV 3. Wireless communication 4. Back up electrical supply in enough capacity
Any comment as you like	

Thank you very much for your understanding and cooperation.

Your Name Arvind Kumar

Position/Organization Executive Engineer, UJVNL

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The Consultation Meeting for the Preparation of Inspection Manual for Dam Field Engineers after the Seismic Events

20 -22 April, 2016 , Dehradun India

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Is the Consultation Meeting valuable for you?		☑ YES	☐ NO		
Please indicate the points you enjoyed.	-There should be an information flow present which propagates information related to events swiftly. -Inspection categories like quick inspection & detailed inspection & further to ensure the damages				
How do you rate the Consultation Meeting?	EXCELLENT 5	4 ✓	3	2	POOR 1
Please indicate the points you felt.					
What is the impressive of the Consultation Meeting?	The information & knowledge shared by JWA officials since Japan is having a lot in the field of Earthquake & seismology				
Did you understand that the prompt response is required after seismic event?	Well understood ☑	Understood ☐	Not really ☐		
Comments, if any.					
Did you think *the Check List* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐		
Comments, if any.	The checklist very much helps the workforce how to act in a correct & swift way.				

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Did you understand how to use the *Inspection Manual*?	Well understood ☐	Understood ☑	Not really ☐
Comments, if any.			
Did you think *the Inspection Manual* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐
Comments, if any.			
Do you think the program of this workshop can be applied to your capacity building especially for Field Engineer ?	Applicable ☐	Relatively applicable ☑	Not applicable ☐
Comments, if any.	Since my field is related to the communications which is an imperative aspect of reporting, this workshop definitely useful		

What king of instrument is required to improve the response for the Earthquakes for your facilities?	Seismic meters, Communication equipments (preferably a private network)
Any comment as you like	The flow of information, which could be highly efficient if new ways to communicate will be applied. These communication facility should be highly resilient to failures. These systems should be focused a lot.

Thank you very much for your understanding and cooperation.

Your Name RACHIT PHARIYAL

Position/Organization Assistant Engineer (Information Technology)

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Is the Consultation Meeting valuable for you?	☑ YES	☐ NO			
Please indicate the points you enjoyed.	check points during survey of Dams.				
How do you rate the Consultation Meeting?	EXCELLENT ✓ 5	4	3	2	POOR 1
Please indicate the points you felt.	Improving the knowledge for action to be taken in the event of Earthquake.				
What is the impressive of the Consultation Meeting?	Immediate action for protection after any Earthquake.				
Did you understand that the prompt response is required after seismic event?	Well understood ☑	Understood ☐	Not really ☐		
Comments, if any.	To ensure safety of Dam structures.				
Did you think *the Check List* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐		
Comments, if any.	useful for healthiness of Dam.				

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Did you understand how to use the *Inspection Manual*?	Well understood ☐	Understood ☑	Not really ☐
Comments, if any.	Will help in proper checking of equipments and reliability.		
Did you think *the Inspection Manual* is useful for practicing for seismic event?	Very useful ☑	Relatively useful ☐	Not so useful ☐
Comments, if any.			
Do you think the program of this workshop can be applied to your capacity building especially for Field Engineer ?	Applicable ☑	Relatively applicable ☐	Not applicable ☐
Comments, if any.	To ensure the safety of structure.		

What king of instrument is required to improve the response for the Earthquakes for your facilities?	– Earthquake measurement – Deformation measurement – Levels.
Any comment as you like	The training is very useful against the protection of an earthquake and immediate action to ensure the healthiness of system.

Thank you very much for your understanding and cooperation.

Your Name K. K. Jaiswal

Position/Organization Executive Engineer

Appendix 5

Checklist and Manual for Quick Check

Report on earthquake response of Ichari dam	Date: / / Serial No.

Report on extraordinary inspection

Following are the result of quick inspection after the earthquake

Inspection result

Dam body

Surrounding moutains

Gates and volves

Others

State of the earthquake or flood
Event date & time: : / /
Event location:
Seizmic Intensity at nearest point:
Observed Accelaration X= gal, Y= gal, Z= gal

Signature for confirmation

Task force in field

Head	Staff	Officer in charg	Dispatch date & time
			: , / /

Emergency Response Headquarters

	Chief	Deputy Chief	group leader	Officer in charg
H Q				

Draft

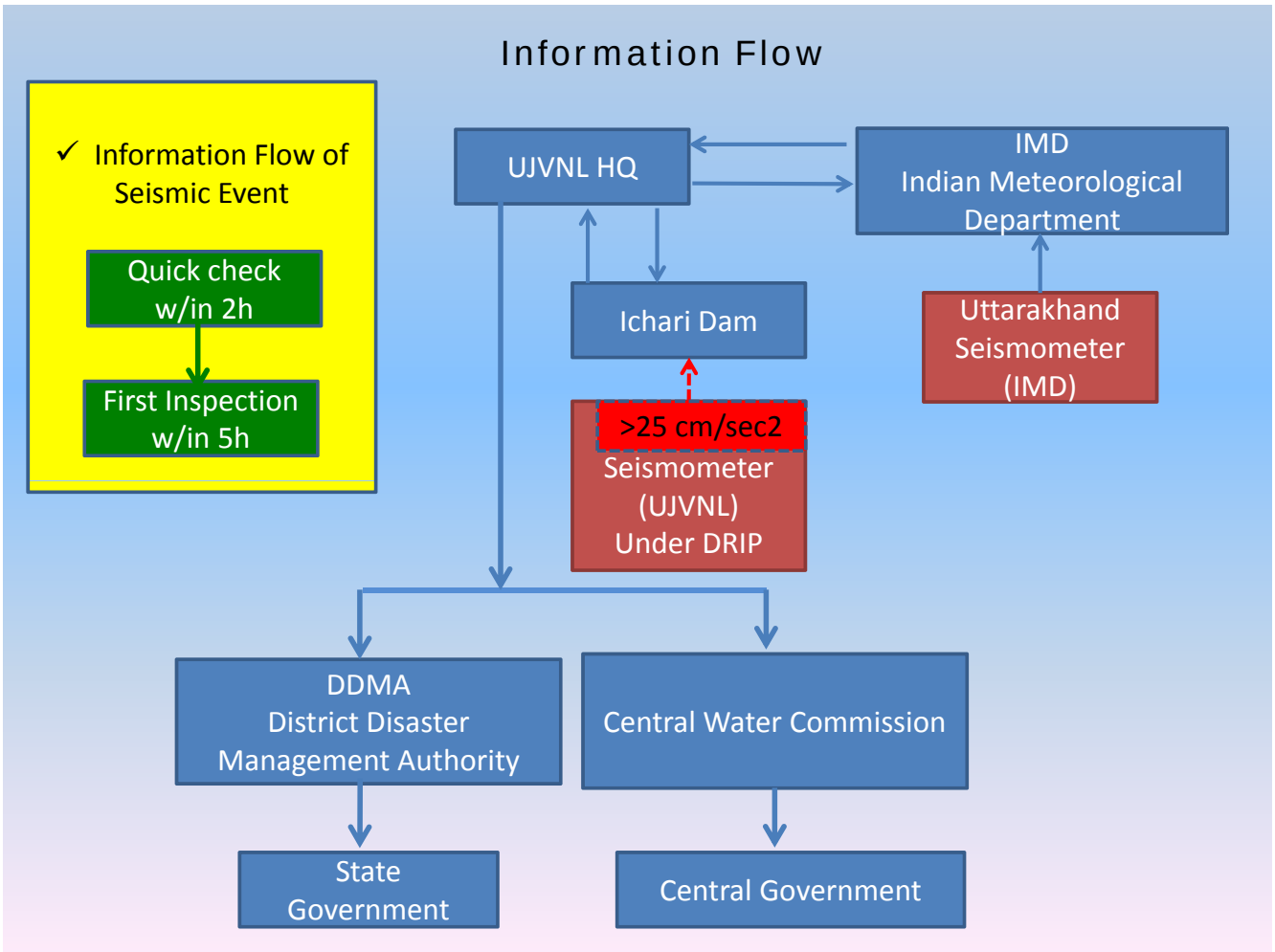
Manual

for Post-earthquake Inspection

Quick check

Ichari Dam

Ver.2016 October

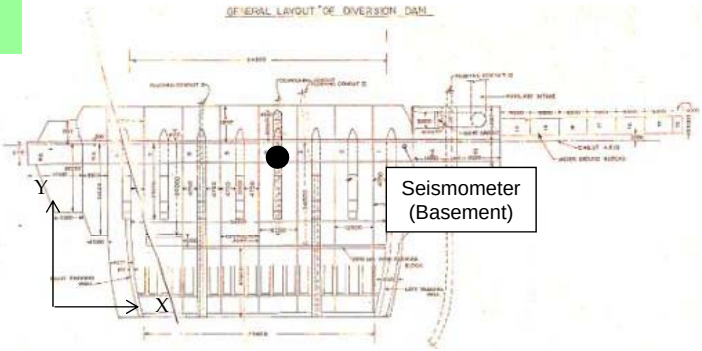


Earthquake Intensity for Action

Installed seismometer (Basement)

Acceleration

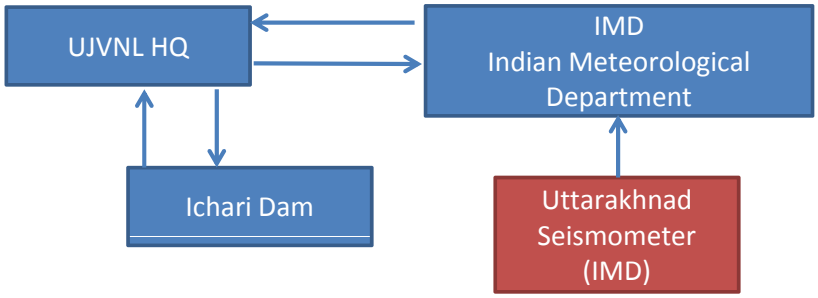
>25 cm/sec2



OR

Seismic information from HQ of UJVNL

(Data from Indian Meteorological Department)

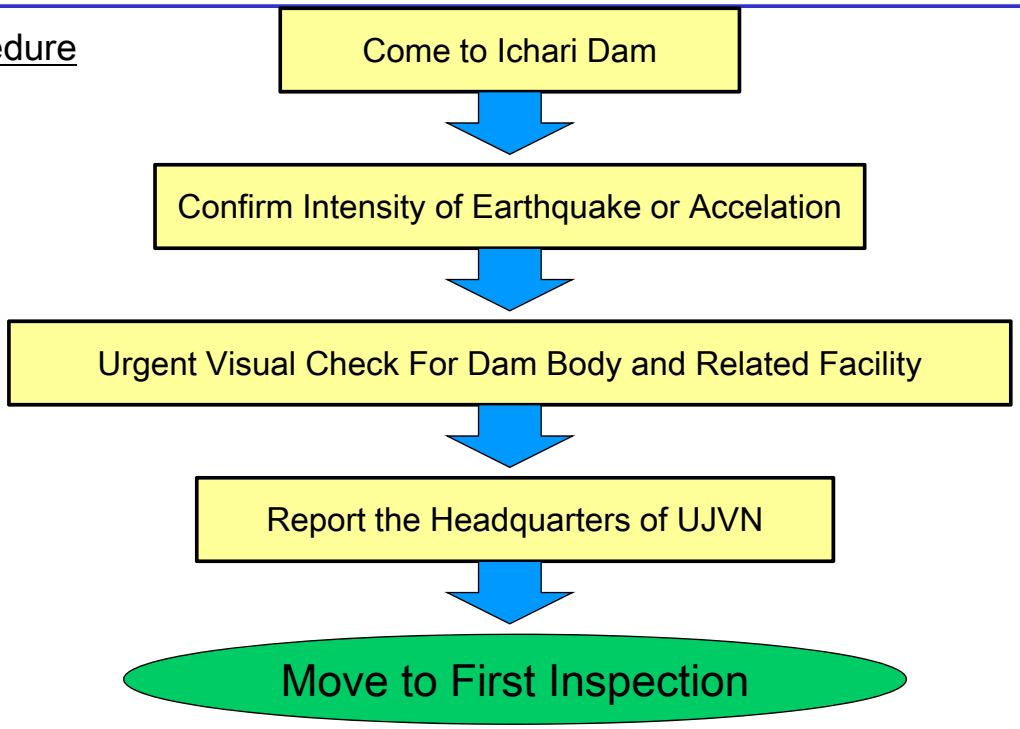


Quick Check

Purpose of Quick Check

To urgently report received seismic intensity and acceleration and any obvious damage which leads to dam failure, within two hours

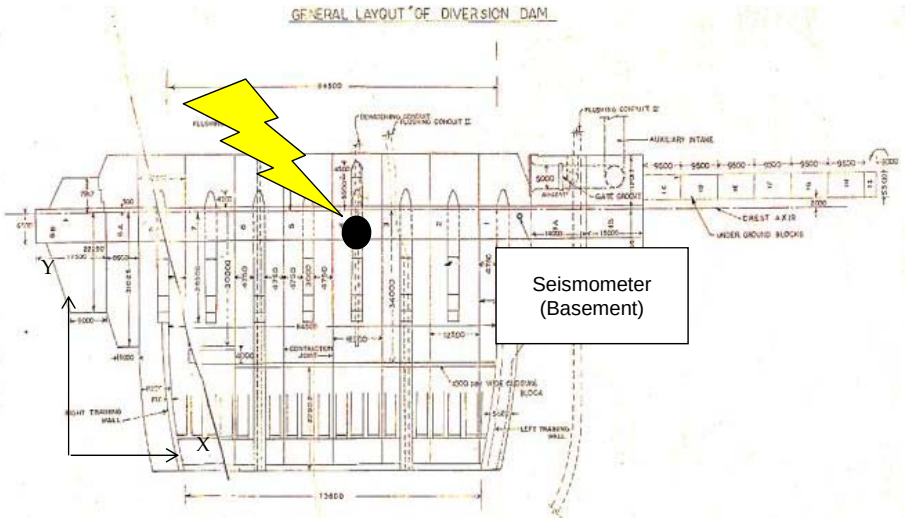
Procedure



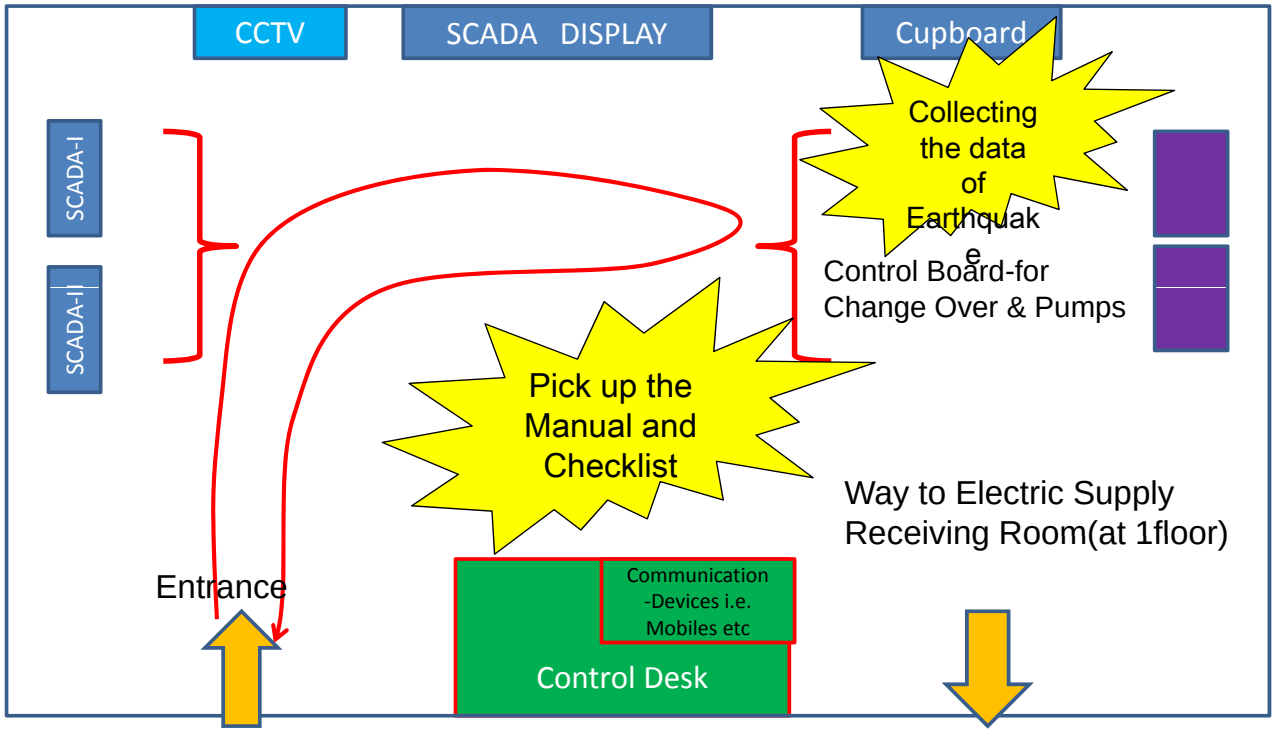
Tools for inspection

- ✓ Writing kit
- ✓ Camera
- ✓ Mobile phone / Walkie-Talkie
- ✓ Helmet
- ✓ Keys
- ✓ Flashlight
- ✓ Checklist

Collecting the data of Earthquake Intensity



Operation-Room, Ichari Dam



Quick Check

The report of the earthquake intensity

Report on earthquake response of Ichari dam | Date: / /
Serial No.

Report on extraordinary inspection (Quick Check)

Following are the result of extraordinary inspection (primary) after the earthquake

Inspection result

Dam body

Surrounding moutains

Gates and volves

Others

Fill in observed data

State of the earthquake or flood
Event date & time: : / /
Event location:
Seizmic Intensity at nearest point:
Observed Accelaration X= gal, Y= gal, Z= gal
Synthetic gal,

Go to Quick inspection Dam Body Gate Surrounding Reservoir

Signature for confirmation

Task force in field

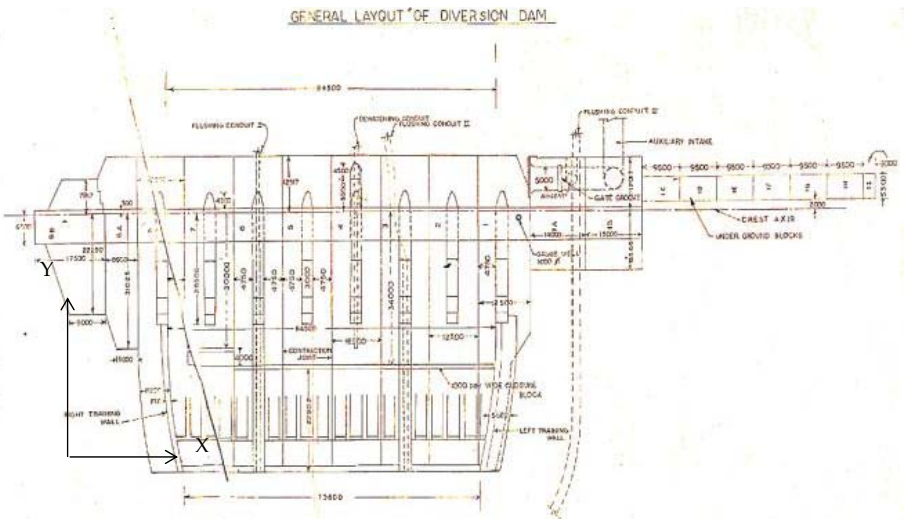
Head	Staff	Officer in charge	Dispatch date & time
			: , / /

Emergency Response Headquarters

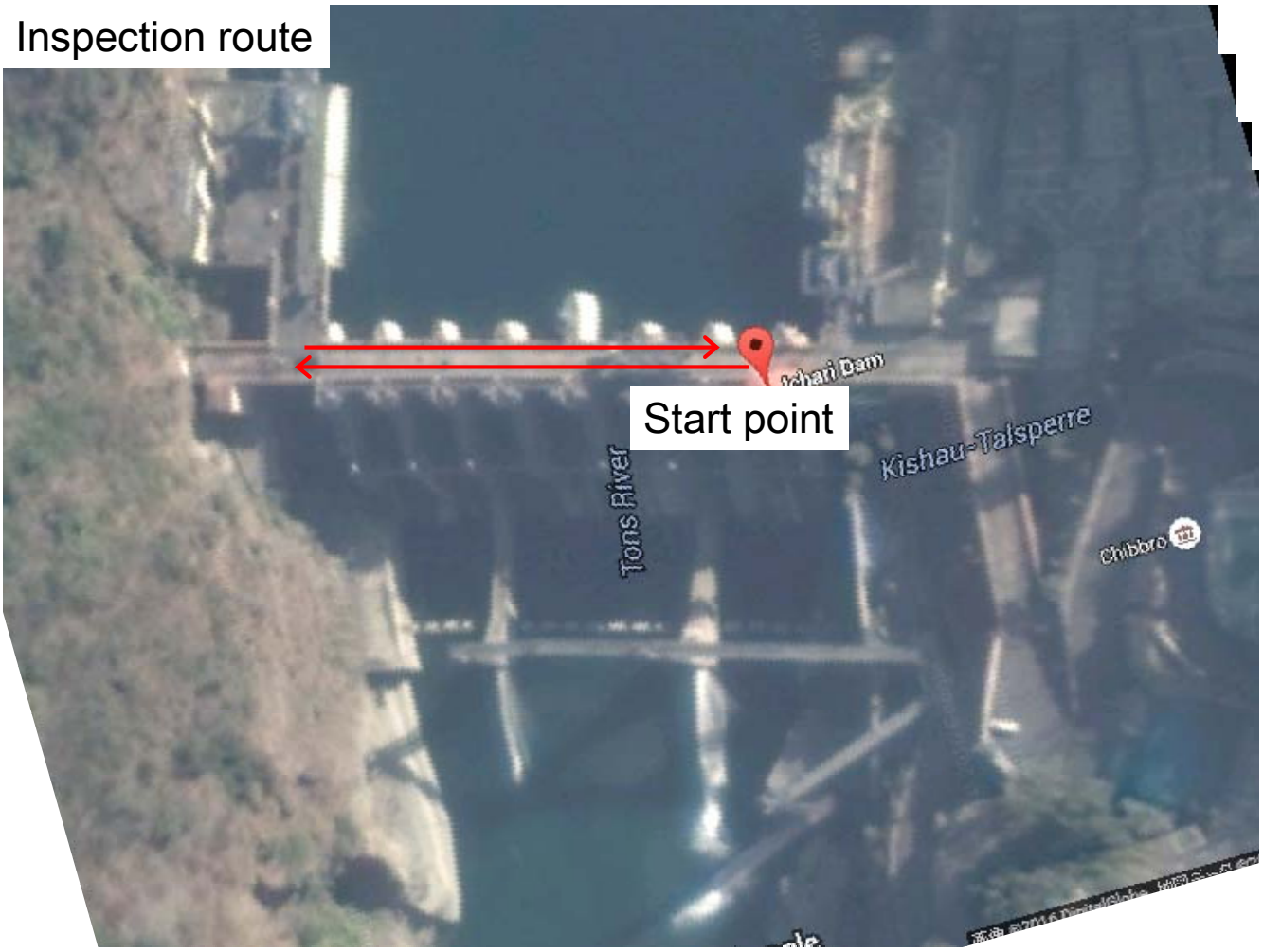
	Chief	Deputy Chief	group leader	Officer in charge
H Q				

Earquake

Quick Inspection for Dam Body and Gate etc.



Inspection route



Any
land slide?

Inspection bridge
Any deformation?

Any change
on dam body?

The bottom of the gate
Any change in leakage?

Check Crest and
Down stream

Check Upstream

Any land slide or failure
Any change in the reservoir

Check upstream of gates

Check the gates

Fill in observed data

Report on earthquake response of Ichari dam

Date: / /
Serial No.

Report on extraordinary inspection (Quick Check)

Following are the result of extraordinary inspection (primary) after the earthquake

Inspection result

Dam body

Surrounding moutains

Gates and volves

Others

State of the earthquake or flood
Event date & time: : / /
Event location:
Seizmic Intensity at nearest point:
Observed Accelaration X= gal, Y= gal, Z= gal
Synthetic gal,

Signature for confirmation

Task force in field

Head	Staff	Officer in charge	Dispatch date & time
			: , / /

Emergency Response Headquarters

	Chief	Deputy Chief	group leader	Officer in charge
H Q				

Report to HQ of UJVN Ltd.

Report by E-mail to

Contact Person of UJVNL Head Quarter	
	Name Post No. E-mail

Quick Check Report Finish
Switch to
First Inspection

Appendix 6

Checklists and Manuals for First Inspection

Ichari dam

Checklist for extraordinary inspection (First Check)

Structures

Inspection time & date

from : / / to : / /

Name of inspector

Structures				Check items	State
Dam	Body	Upstream face	1	Leakage, Crack (visually observe or camera)	
		Downstream face (Spillway section)	2	Leakage, Crack (visually observe or camera)	
		Downstream face (Non-spillway section)	3	Leakage, Crack (visually observe or camera)	
		Gallery	4	Leakage, Crack (visually observe or camera)	
		Bridge (Crest)	5	Collapse, Deformation (visually observe or camera)	
	Others	Control room	6	Crack, any failure (visually observe or camera)	
		Staff room, Labs, Washroom	7	Crack, any failure (visually observe or camera)	
		Construction shaft	8	Crack, any failure, water situation (muddy, lowering) (visually observe or camera)	
		Intake tower	9	Crack, any failure (visually observe)	
		Bridge (Access road)	10	Collapse, Deformation (visually observe or camera)	
		Bridge (Gate section)	11	Collapse, Deformation (visually observe or camera)	
		Bridge (Flushing gate 1,2)	12	Collapse, Deformation (visually observe or camera)	

		Bridge (Flushing gate 3)	13	Collapse, Deformation (visually observe or camera)	
		Railing and fencing	14	Deformation (visually observe or camera)	
Around reservoir	Moutains	Right bank	15	Collapse, Land slide (visually observe or camera)	
		Left bank	16	Collapse, Land slide (visually observe or camera)	
	Roads	Road on right bank	17	Slopes, retaining walls (camera)	
		Road on left bank	18	Slopes, retaining walls (camera)	
	Reservoir	Slope	19	Collapse, Land slide (Camera)	
		Inflow of the river	20	Change inflow pattern, reservoir water level (visually observe or camera)	
	River	Downstream protection works	21	Collapse, Deformation (visually observe or camera)	

Draft

Manual

for Post-earthquake Inspection

First Inspection on Dam Structures

Ichari Dam

Ver. 2016 October

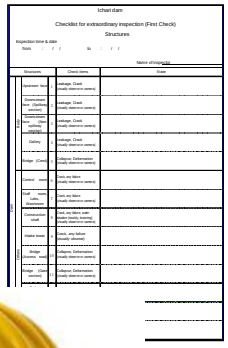
First Inspection manual For Dam Structure

Purpose of First Check

To urgently confirm the state of dam safety and facility to operate gate system and the telecommunication

Tools for inspection

- ✓ **Writing kit**
- ✓ **Camera**
- ✓ **Mobile phone / Walkie-Talkie**
- ✓ **Helmet**
- ✓ **Keys**
- ✓ **Flashlight**
- ✓ **Checklist**



Principle

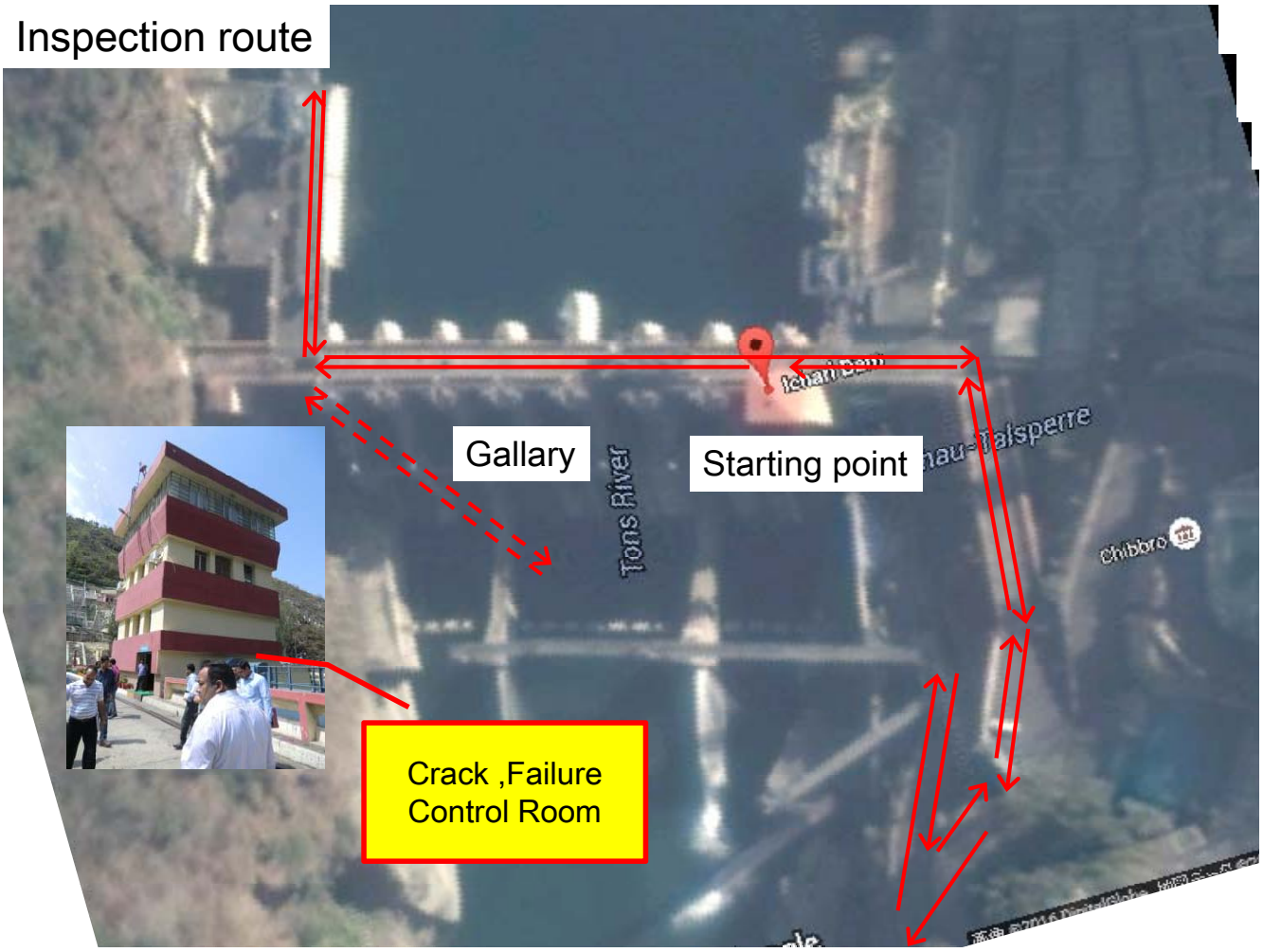
1. **After the Quick Check, the First Inspection shall be immediately started**
2. **The report must be submitted to UJVNL HQ within 5hrs after earthquake**
3. **Major check items are as follows**

dam body, operation rooms, surrounding slopes, mechanical facilities and telecommunication system

The first check of structure can be divided into three portion

Surface of Dam Body, Buildings
Inspection Galley
Around Reservoir

Inspection route



Observe downstream face from inspection bridge

Watch your Step!

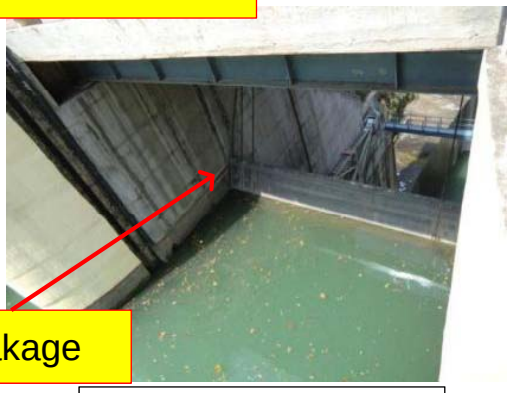
Body

Spillway section

Leakage,Crack
(Spillways,Walls)

Downstream face

Crack , Deformation



Leakage

Upstream face

Observe upstream face from right side abutment

Body

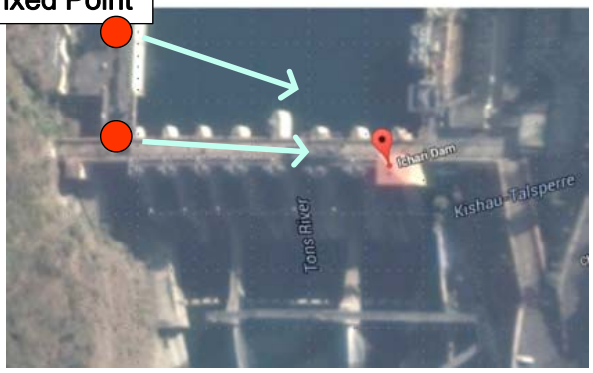
Upstream face

Upstream face(Pier):
Crack , Deformation

Bridge:
Collapse , Deformation

Damage of the joint of blidge

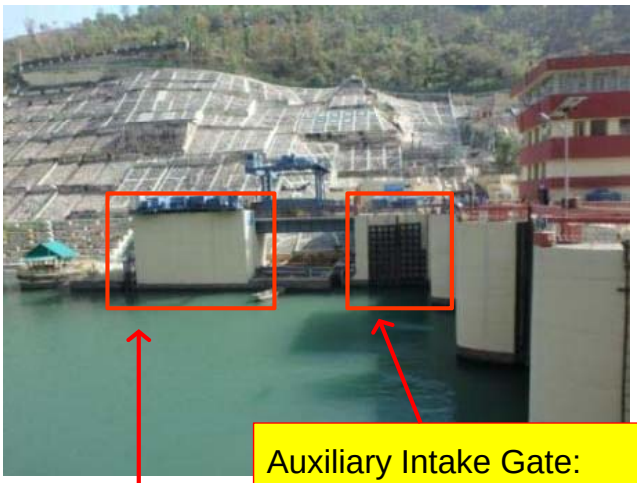
Fixed Point



Upstream face

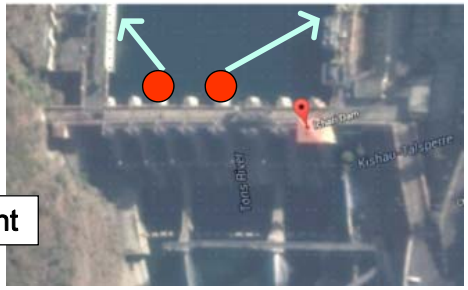
Body & Others

Intake Gate
Crack , Deformation



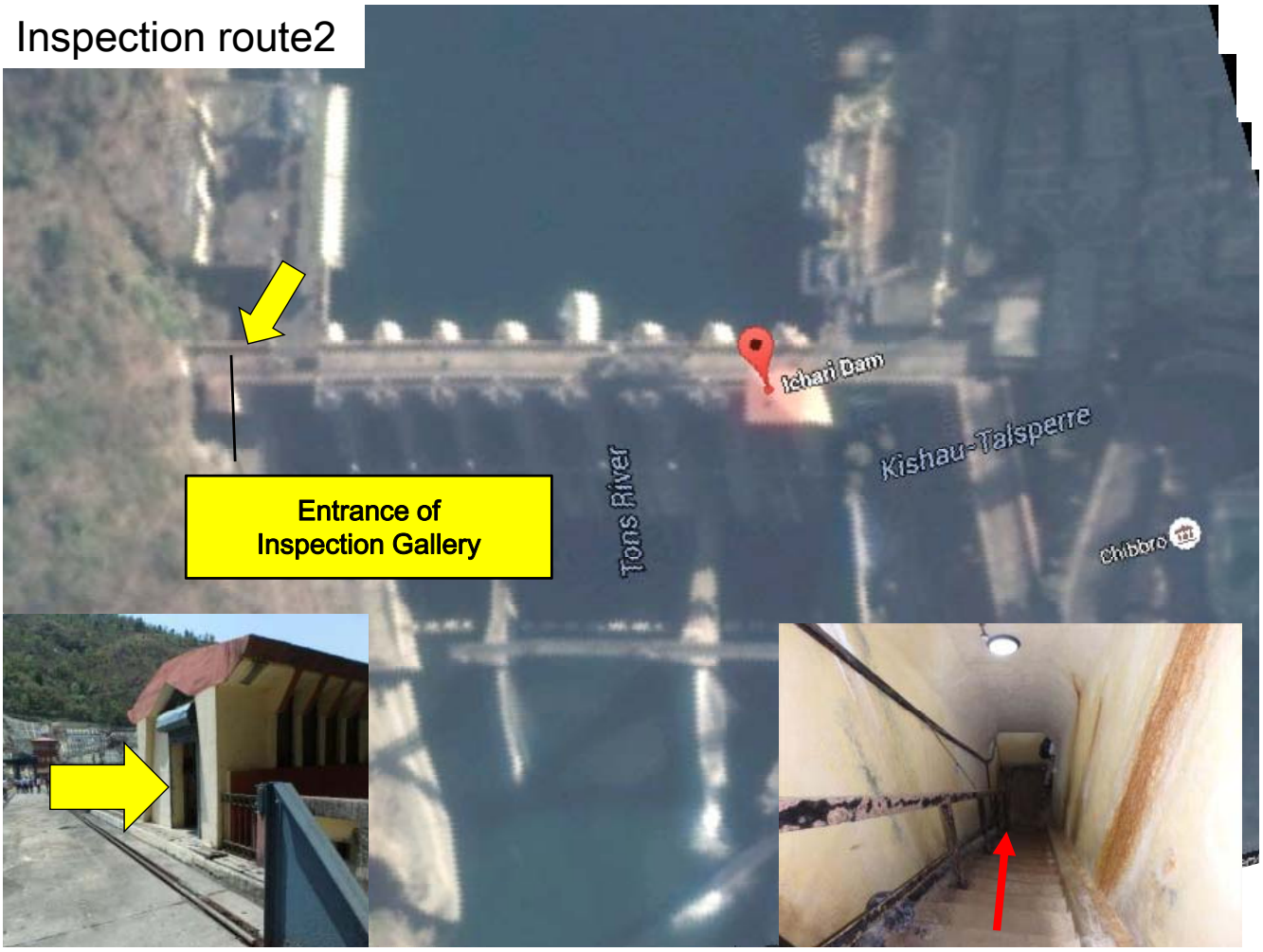
Auxiliary Intake Gate:
Crack , Deformation

Tunnel Control Gate(TCG):
Crack , Deformation



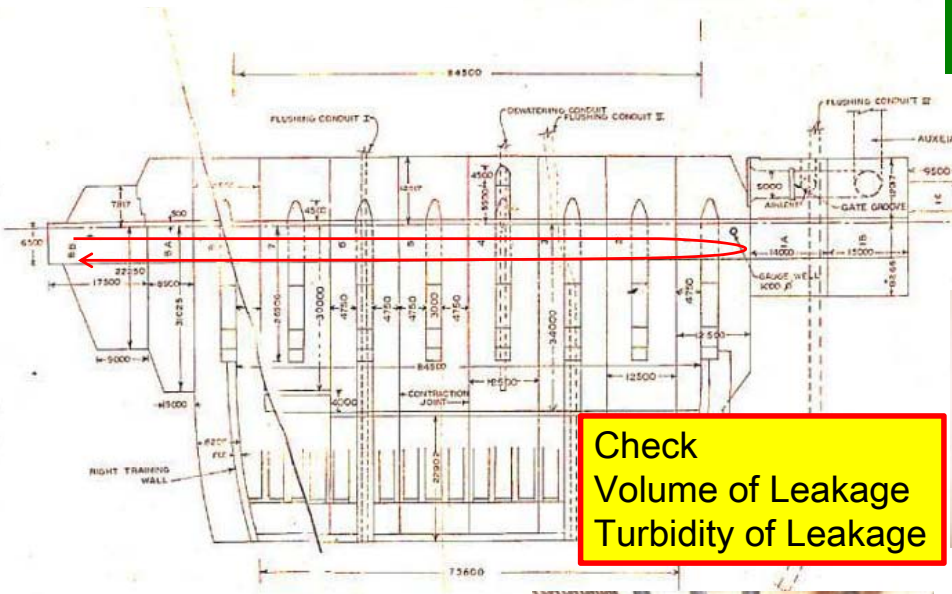
Fixed Point

Inspection route2



Inspection route for No.2

Gallery



Check
Volume of Leakage
Turbidity of Leakage

Drain hole for Mechanical Joint

Water Tank

Drain hole

Upstream

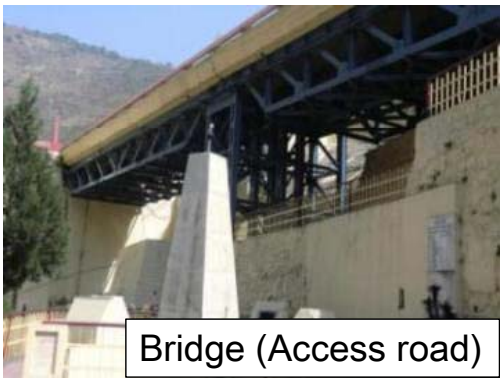
Crack
or
Deformation

Downstream face
Of Operation Building
Non spillway section

Bridge (FC Gate)

Body &Others

Deformation



Bridge(Gate Section)

Bridge (Access road)

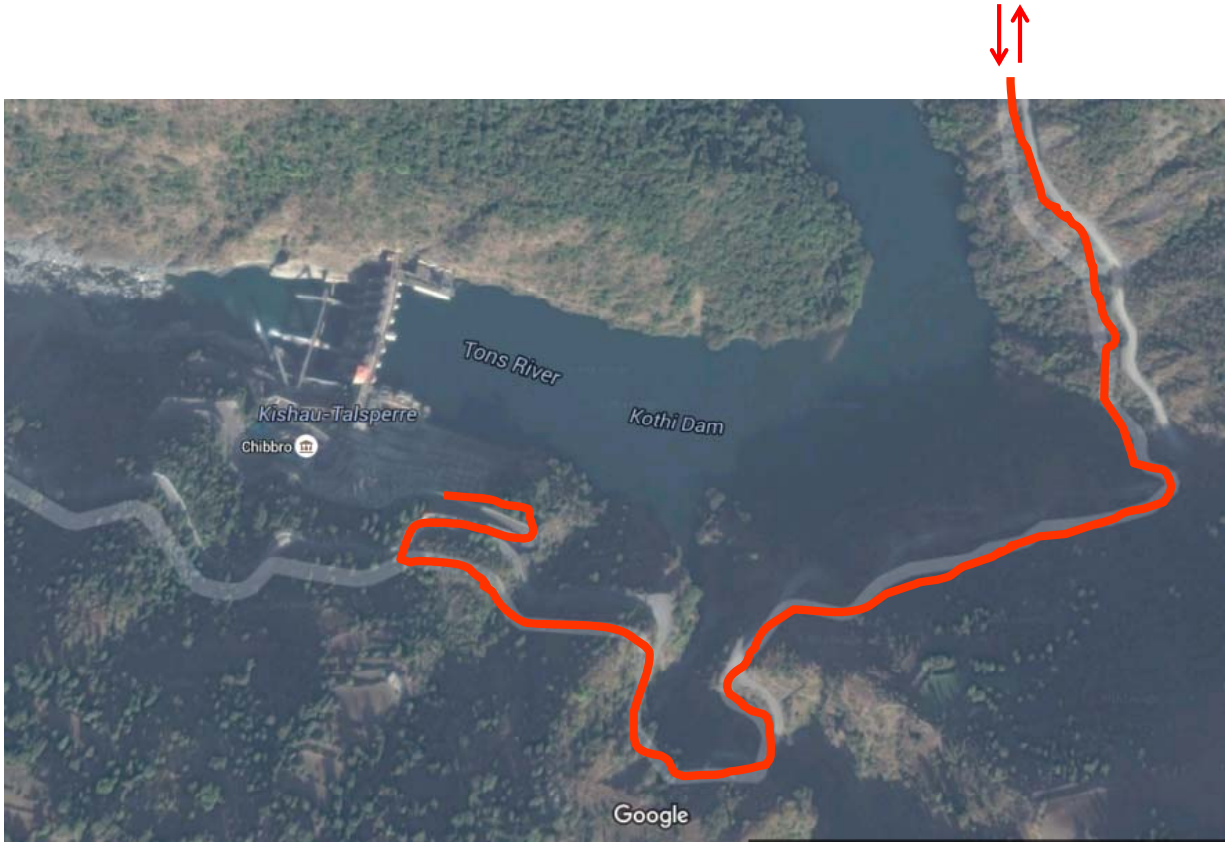
Body

Crack , Leakage
Deformation

Watch your Step!
If bridge has collapsed ,forgive to inspect it

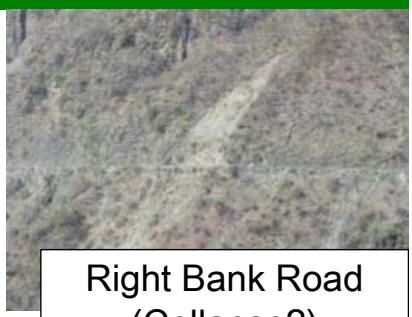
Downstream face

Inspection route for resurvoir



Around Reservoir

Collapse
Land Slide
Turbid water



Right Bank Road
(Collapse?)

Fill out reporting form and submit

Ichari dam

Checklist for extraordinary inspection (First Check)

Structures

Inspection time & date

from : / / to : / /

Name of inspector

		Structures		Check items	State
Dam	Body	Upstream face	1	Leakage, Crack (visually observe or camera)	
		Downstream face (Spillway section)	2	Leakage, Crack (visually observe or camera)	
		Downstream face (Non-spillway section)	3	Leakage, Crack (visually observe or camera)	
		Gallery	4	Leakage, Crack (visually observe or camera)	
		Bridge (Crest)	5	Collapse, Deformation (visually observe or camera)	
	Others	Control room	6	Crack, any failure (visually observe or camera)	
		Staff room, Labs, Washroom	7	Crack, any failure (visually observe or camera)	
		Construction shaft	8	Crack, any failure, water situation (muddy, lowering) (visually observe or camera)	
		Intake tower	9	Crack, any failure (visually observe)	
		Bridge (Access road)	10	Collapse, Deformation (visually observe or camera)	
		Bridge (Gate section)	11	Collapse, Deformation (visually observe or camera)	
		Bridge (Flushing gate 1,2)	12	Collapse, Deformation (visually observe or camera)	
		Bridge (Flushing gate 3)	13	Collapse, Deformation (visually observe or camera)	
		Railing and fencing	14	Deformation (visually observe or camera)	

Around reservoir	Moutains	Right bank	15	Collapse, Land slide (visually observe or camera)	
		Left bank	16	Collapse, Land slide (visually observe or camera)	
	Roads	Road on right bank	17	Slopes, retaining walls (camera)	
		Road on left bank	18	Slopes, retaining walls (camera)	
	Reservoir	Slope	19	Collapse, Land slide (Camera)	
		Inflow of the river	20	Change inflow pattern, reservoir water level (visually observe or camera)	
	River	Downstream protection works	21	Collapse, Deformation (visually observe or camera)	

Fill in observed data

Report to HQ of UJVN Ltd.

Report with Result of

Mech. and E&T

by E-mail to

Contact Person of UJVNL Head Quarter	
	Name Post No. E-mail

End

Ichari Dam
Checklist for initial extraordinary inspection
Mechanical equipment

Implementation Date Time ～ Date Time

Name

	Name of Equipment		Check Item	Procedure	State																		Reference
					Spillway Gate							FC gates			TCS		Dewatering Gate	Auxiliary Gate	Intake Gate				
					#1	#2	#3	#4	#5	#6	#7	#1	#2	#3	#1	#2	#1	#1	#1	#2	#3	#4	
	Gates	Opening and Closing Equipment, Wire rope	Leaning	Visual Check																			
			Leak of oil	Visual Check																			
		Local operation board	Leaning	Visual Check																			
			lighting position (normal / abnormal), Leaning	Visual Check																			
		Operation Board	Leaning	Visual Check																			
			Abnormarity display	Visual Check																			
		Gate and gate stop	Crack or deformation	Visual Check																			
			Leakage	Visual Check																			
	Inspection Boat			Visual Check																			
	Elevator		Don't Use(Sign Board)																				
	Drainage Pump	Local operation board	Leaning	Visual Check																			
		Drainage	Drainage Water from drain outlet	Visual Check																			

Remark

Draft

Manual

for Post-earthquake Inspection

First Inspection on Mechanical Facilities

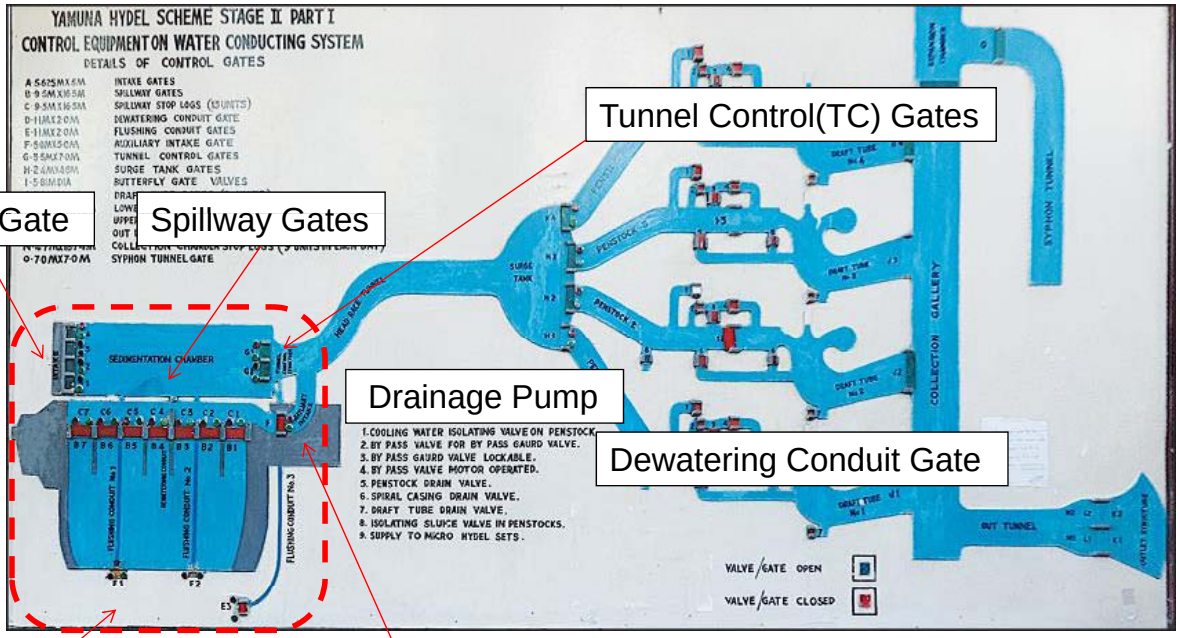
Ichari Dam

Ver.2016 October 16

Tools for inspection

- ✓ Writing kit
- ✓ Camera
- ✓ Mobile phone / Walkie-Talkie
- ✓ Helmet
- ✓ Glove
- ✓ Keys
- ✓ Flashlight
- ✓ Checklist
- ✓ Binocular

Concerned Facilities



Tunnel Control(TC) Gates

Intake Gate

Spillway Gates

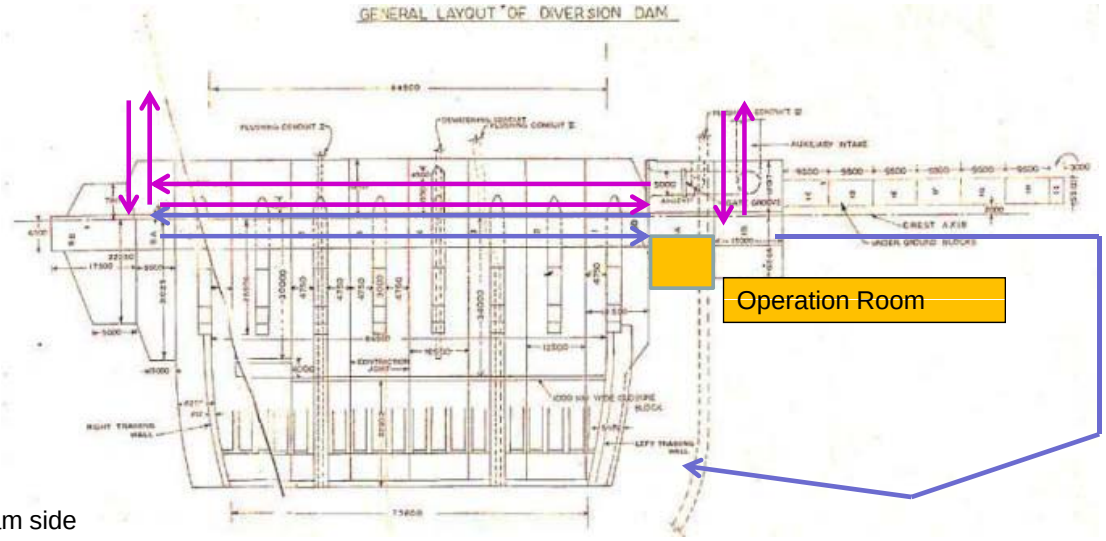
Drainage Pump

Dewatering Conduit Gate

Flushing Conduit (FC) Gate

Auxiliary Intake Gate

Check Round



Downstream side

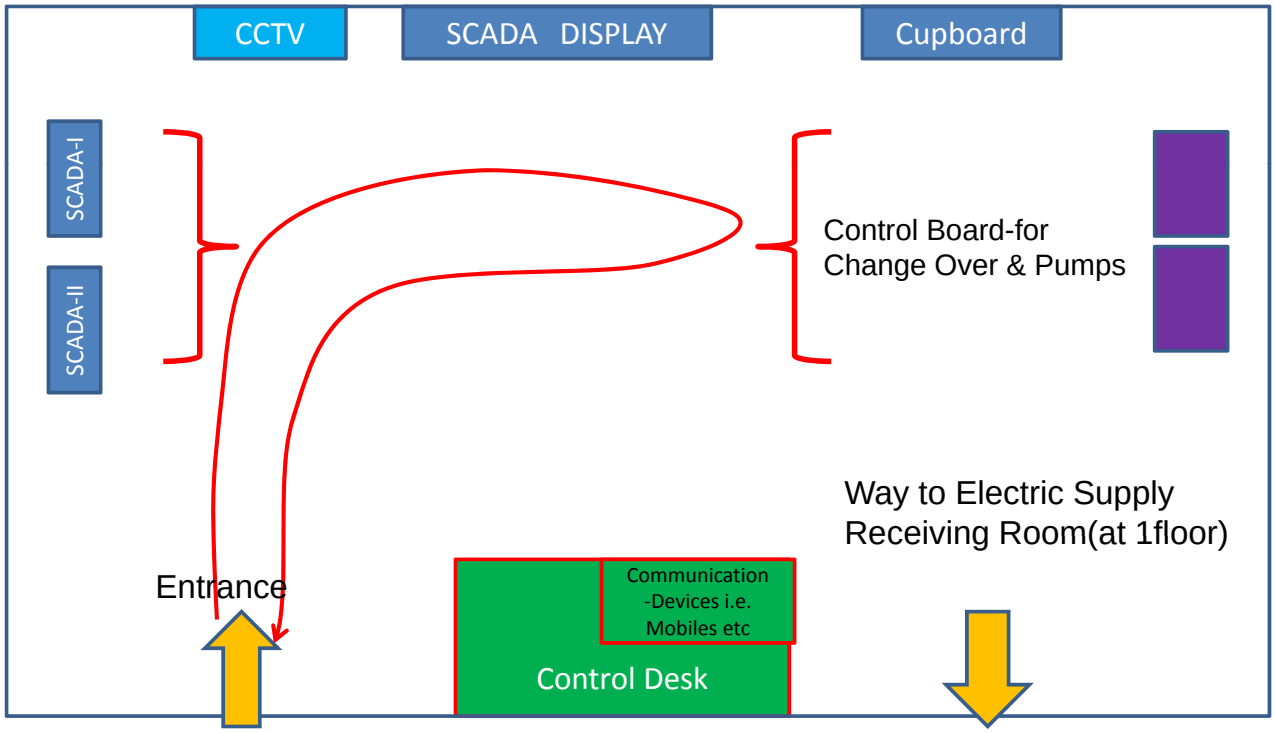
Operation Room → Spillway Gate → FC Gate → Intake Gate

FC: Flushing Conduit

Intake Gate → Auxiliary Intake Gate → TC Gate → Inspection Boat → Dewatering Gate → Drainage Pump

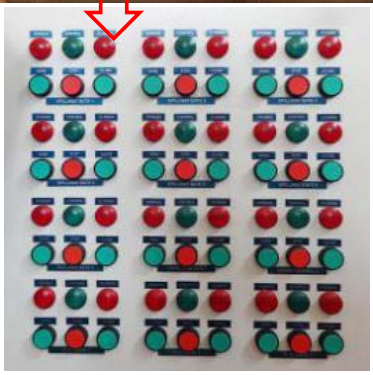
TC Gate :Tunnel Conduit Gate

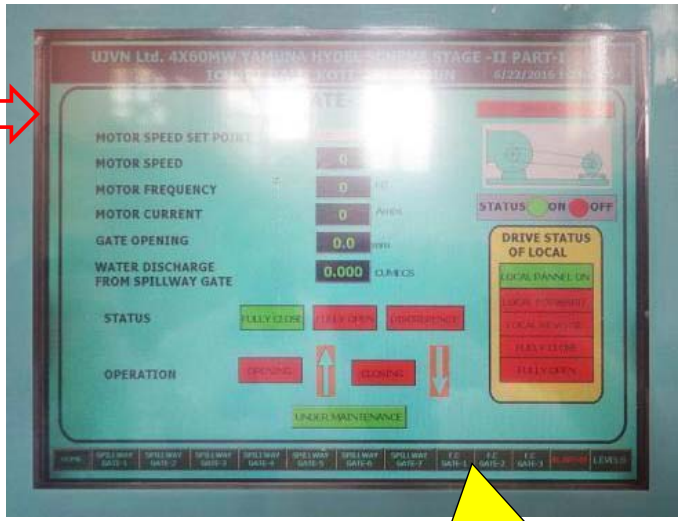
Operation-Room, Ichari Dam



Method of confirmation using operation board(SCADA I,II)

Operation board





State of Mechanical function of Ichri Dam

Method of confirmation about Control Board- for Change Over & Pumps

Operation board

Check the lump and number of monitor

Method of confirmation about the gates using CCTV

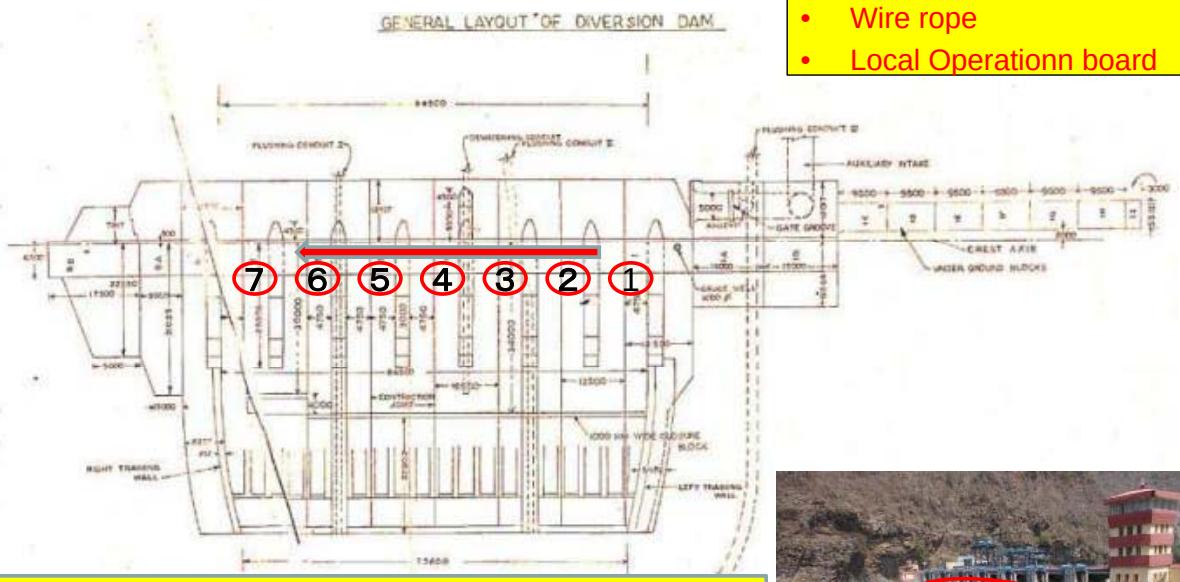
Confirm the condition of gates and other facilities by CCTV

If you can check the gates and other facilities condition, you do not need to go confirmed sites.

Directions to Spillway Gates

(Local operation board, opening and closing equipment of spillway gate)

- The deformation of structure
- The open closing equipment
- Wire rope
- Local Operationn board



Leak of Water from gate?
(Abnormal volume of water)

7 6 5 4 3 2 1

Confirm the status of gate1 to 7

Method of confirmation about Spillway Gates

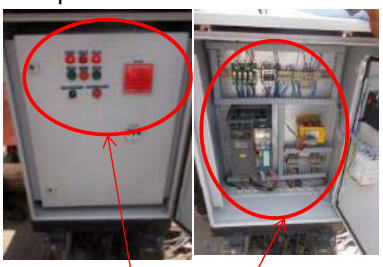
(Local operation board, opening and closing equipment of spillway gate)

Spillway Gate

Opening and Closing Equipment

Wire Rope

Local operation board



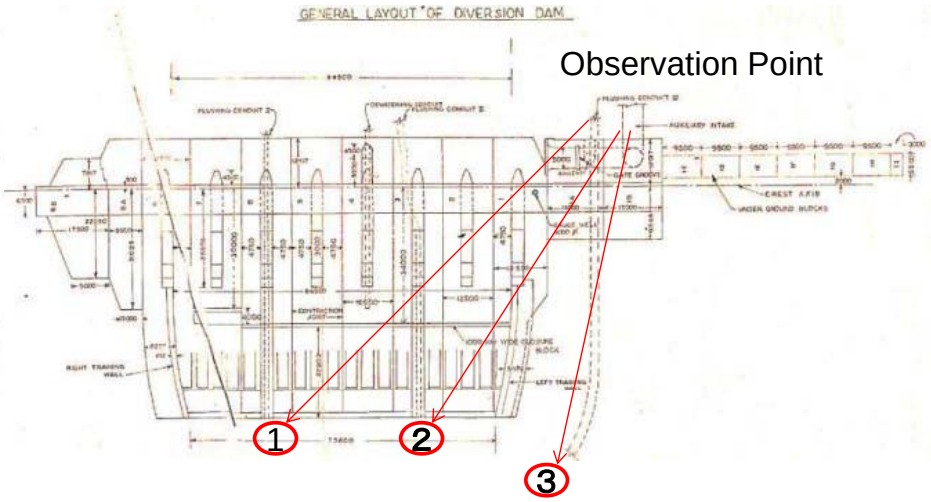
Leaning ?
Leak of Oil?
Damage of Foundation?
Looseness of Wire rope?

Check lighting Position
(normal/abnormal)

Confirm the status of gate1 to 7

Directions to Flushing Conduit (FC) Gate

(Local operation board, opening and closing equipment of FC gate)



- The deformation of structure
- The open closing equipment
- Wire rope
- Local Operationn board

Method for the confirmation for Flushing Conduit (FC) Gate

Local operation board, opening and closing equipment of FC gate)

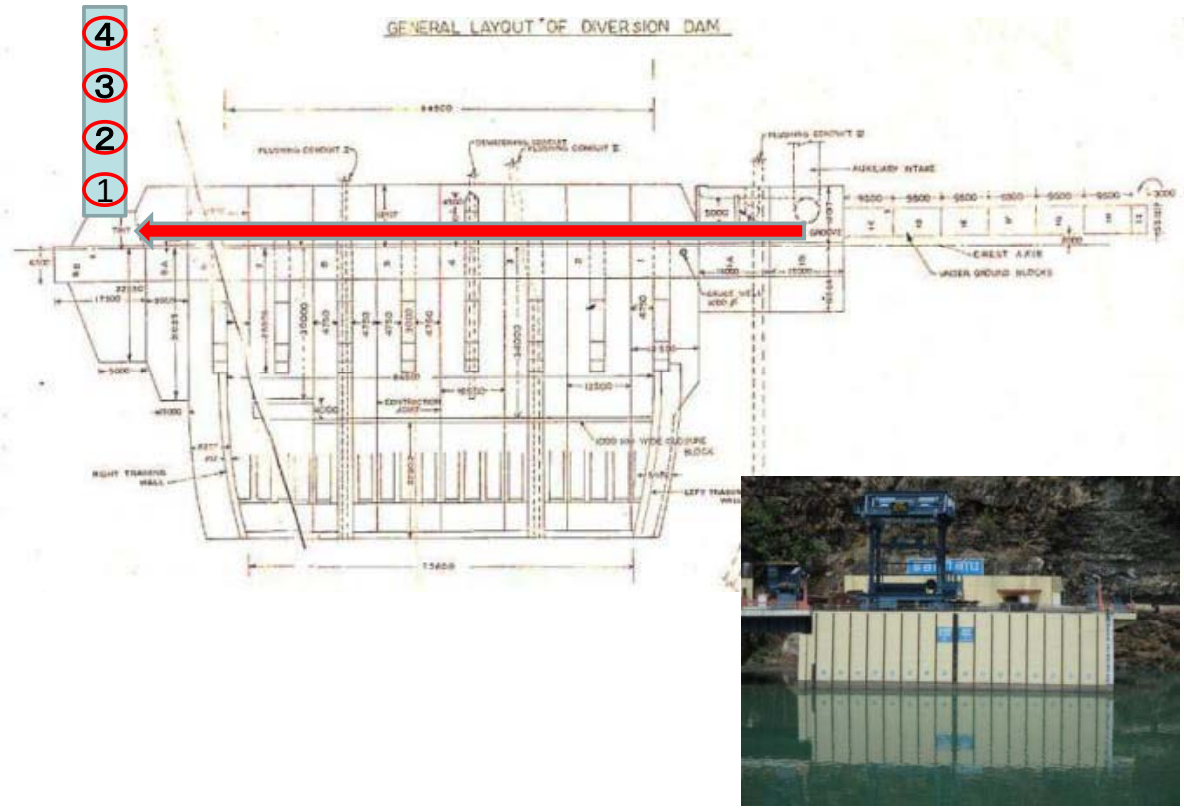
Leak of Water from gate?
(Abnormal volume of water)

3 2 1

- Local operation board (lump, panel)
- Opening Closing Equipment (leak oil, leaning, damage of foundation, looseness of wire rope)

Directions to Intake Gate

(Local operation board, opening and closing equipment of Intake Gate)



Method of confirmation about Intake Gates

(Local operation board, opening and closing equipment of Intake Gate)

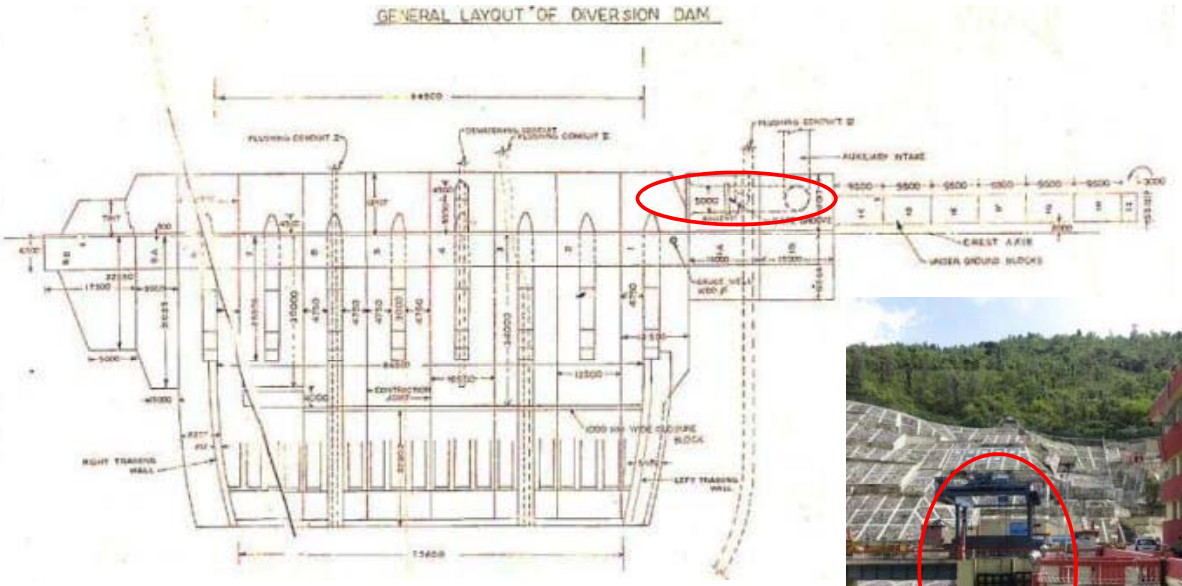
Intake Gate

- Gate (The deformation of structure)

- Opening Closing Equipment (leak oil, leaning, damage of foundation)

Directions to Auxiliary Intake Gate

(Local operation board, opening and closing equipment of Auxiliary gate)



Method of confirmation for Auxiliary Intake Gates

(Local operation board, opening and closing equipment of Auxiliary Intake gate)

Auxiliary Intake Gate

- The deformation of structure
- The open closing equipment
- Wire rope
- Local Operationn board

Method of confirmation for Auxiliary Intake Gates

(Local operation board, opening and closing equipment of Auxiliary Intake gate)

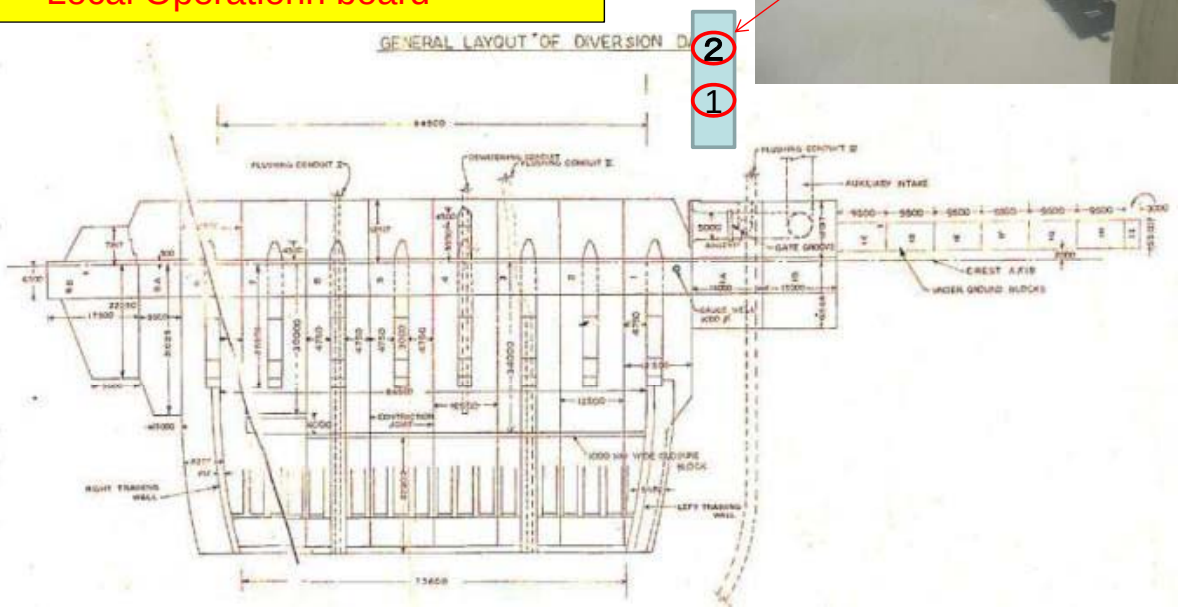
Auxiliary Gate

- Local operation board (lump, panel)
- Opening Closing Equipment (leak oil (around of Opening Closing Equipment), looseness of wire rope)

Directions to Tunnel Conduit (TC)Gate

(Local operation board, opening and closing equipment of Tunnel Control Gate)

- The deformation of structure
- The open closing equipment
- Wire rope
- Local Operationn board



Method of confirmation about Tunnel Conduit (TC) Gate

(Local operation board, opening and closing equipment of TC Gate)

TCG

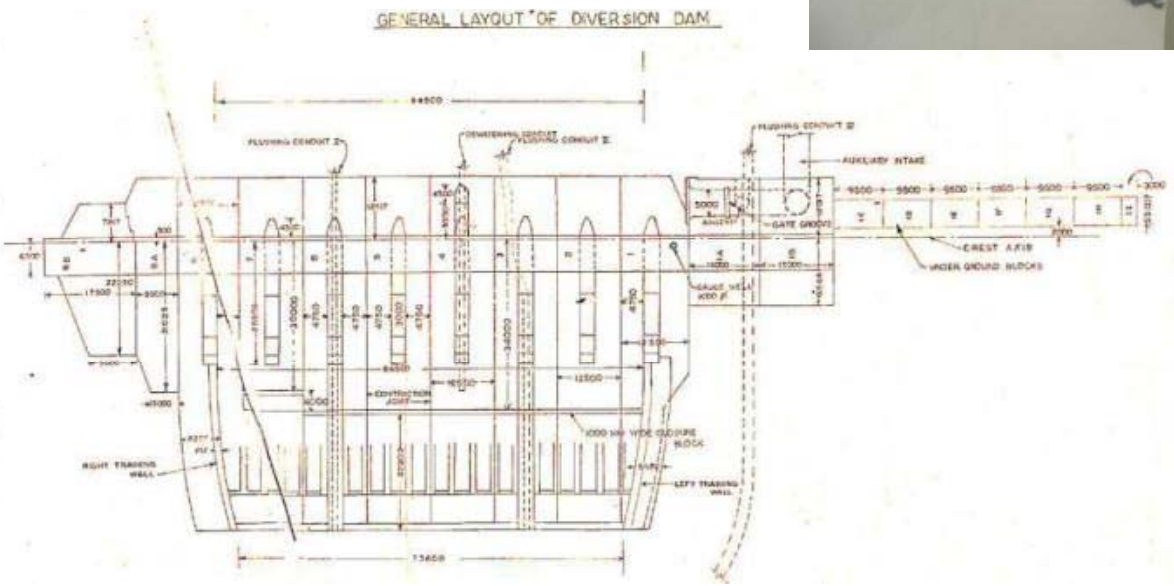
2
1

2
1

- Local operation board (lump, panel)
- Opening Closing Equipment (leak oil (around of Opening Closing Equipment), looseness of wire rope)

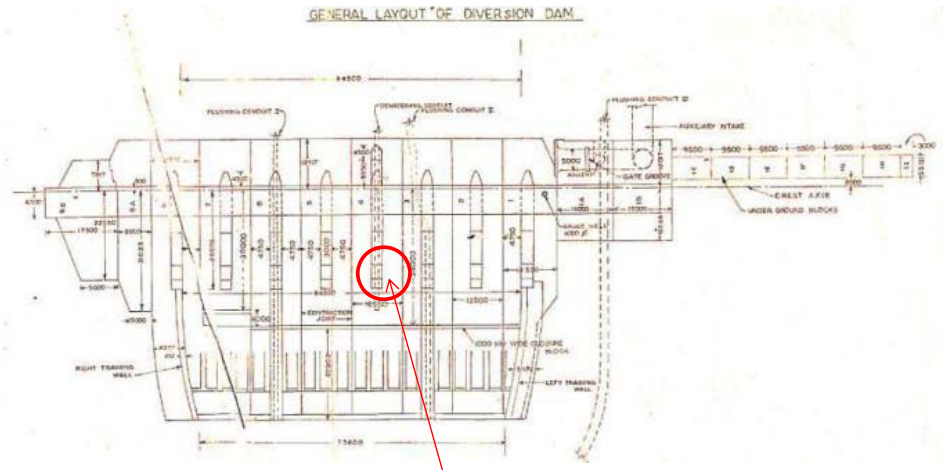
Directions to Anchorage of inspection boat

(Inspection boat)



Directions to Dewatering Conduit Gate and Drain Pump

(Local operation board, opening and closing equipment of Dewatering gate)



Dewatering Conduit Gate

- The deformation of structure
- The open closing equipment
- Wire rope
- Local Operationn board

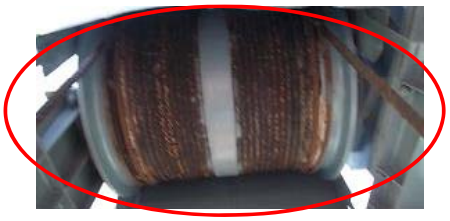
Method for the confirmation Dewatering Conduit Gate

Local operation board, opening and closing equipment of Dewatering Gate

Leak of Water from gate?
(Abnormal volume of water)

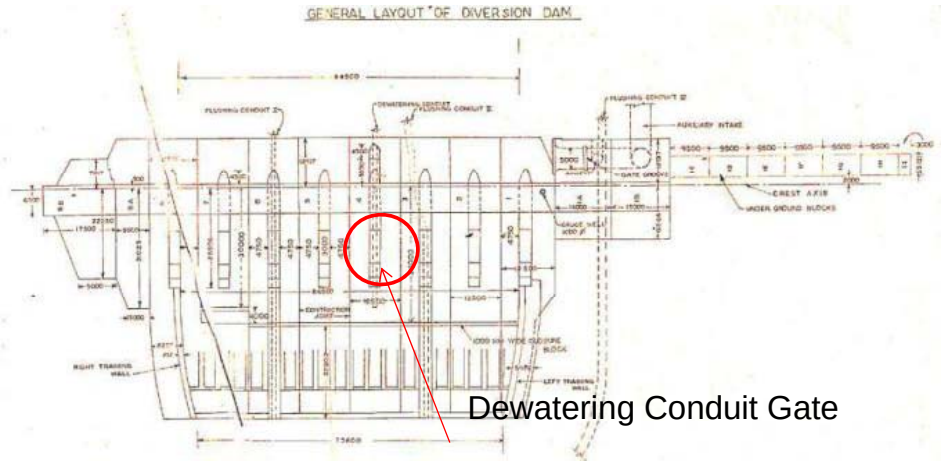
Method for the confirmation Dewatering Conduit Gate

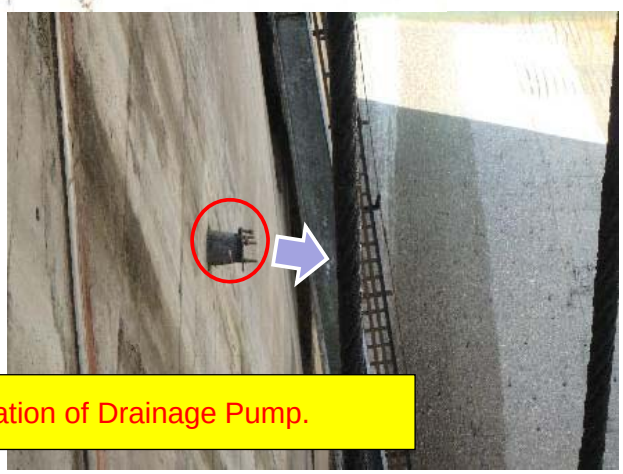
Local operation board, opening and closing equipment of Dewatering Gate



- Local operation board (lump, panel)
- Opening Closing Equipment (leak oil, leaning, damage of foundation, looseness of wire rope)

Method for the confirmation Drainage Pump





- Discharged water ,in test operation of Drainage Pump.

Check List

Ichari Dam
Checklist for initial extraordinary inspection
Mechanical equipment

Implementation Date Time ～ Date Time

Name

Name of Equipment		Check Item	Procedure	State																				Reference
				Spillway Gate							FC gates			TCS		Dewatering Gate	Auxiliary Gate	Intake Gate						
				#1	#2	#3	#4	#5	#6	#7	#1	#2	#3	#1	#2	#1	#1	#1	#2	#3	#4			
Gates	Opening and Closing Equipment, Wire rope	Leaning	Visual Check																					
		Leak of oil	Visual Check																					
	Local operation board	Leaning	Visual Check																					
		lighting position (normal / abnormal), Leaning	Visual Check																					
	Operation Board	Leaning	Visual Check																					
		Abnormarity display	Visual Check																					
	Gate and gate stop	Crack or deformation	Visual Check																					
		Leakage	Visual Check																					
Inspection Boat			Visual Check																					
Elevator		Don't Use(Sign Board)																						
Drainage Pump	Local operation board	Leaning	Visual Check																					
	Drainage	Drainage Water from drain outlet	Visual Check																					

Remark

- Fill in column
- Report Executive Engineer urgently!

End

Ichari Dam

Checklist for initial extraordinary inspection

Electric and Telecommunication equipment

Inspectoin time & date

from : / / to : / /

E & TC	Check items				Procedure	state (✔)	Remarks
Communication Equipment	Wireless communication equipment (ex. micro wave 8.5 GHz)		①	call	Voice Check		
			②	Measuring data check (Received signal level [dBm])	Visual Check		
	Mobile communication equipment (ex. VHF 150 MHz)		①	call	Voice Check		
			②	Measuring data check (Received signal level [dBm])	Visual Check		
	Cable communication		①	call	Voice Check		
Electric power receiving and transforming equipment	Power supply (by electric company)		①	Normal (measuring data check)	Visual Check		
	Emergency generator System	Emergency generator	①	normal (Before test run, Check : fuel, cooling water, starting air)	Test Run/Visual Check		depend on test run time
		Fuel Tank	①	Leaning, Broken, Leak of fuel on the floor	Visual Check		
Electrical equipment	Dam control system		①	Normal (Check display/ panel)	Visual Check		
	Observational equipment (water level, rainfall etc.)		①	Normal (Check display, record)	Visual Check		
	Monitoring camera		①	Normal (Check display/ panel)	Visual Check		
Others							

Draft

Manual

for Post-earthquake Inspection

First Inspection on Electric and Telecomunication Facilities

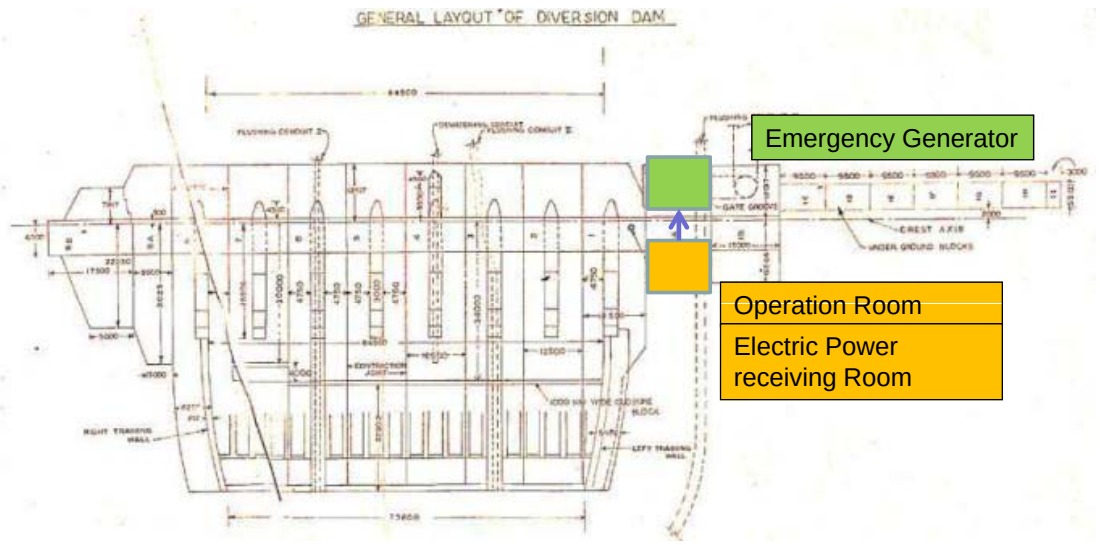
Ichari Dam

Ver. 2016 October

Tools for inspection

- ✓ Writing kit
- ✓ Camera
- ✓ Mobile phone / Walkie-Talkie
- ✓ Helmet
- ✓ Glove
- ✓ Keys
- ✓ Flashlight
- ✓ Checklist

Check Round



Operation room (Visual check) → Electric power receiving room (Visual check) → Emergency generator room (Visual check/ test run)

Emergency generator system

Check Round

Do not use elevator

Operation room (Visual check) → Electric power receiving room (Visual check) → Emergency generator room (Visual check/ test run)

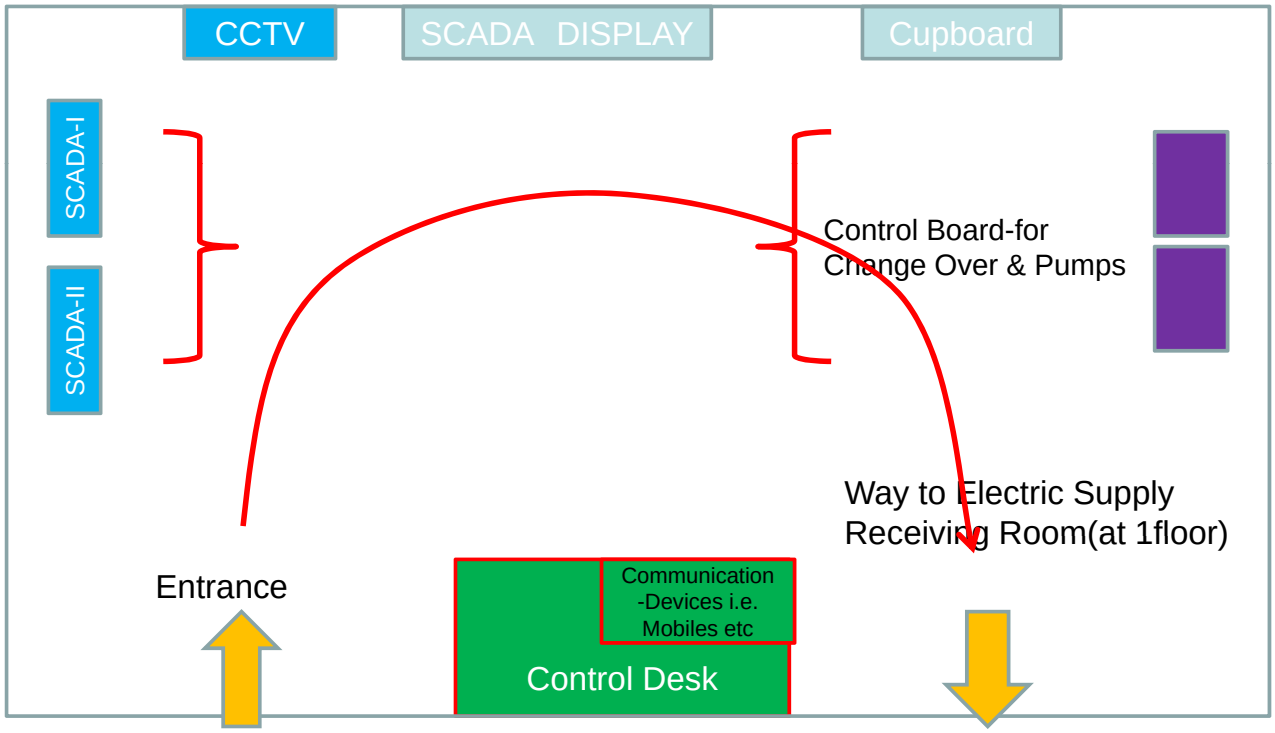
Electrical equipment
Communication equipment

Power supply

Emergency generator system

Direction to Operation room

Operation-Room, Ichari Dam



Method of confirmation about dam monitoring

Dam control system &
observational equipment

Data check of each screen
(normal/abnormal)
&
Record of water level

SCADA-II — Dam Control Console

SCADA-I — Dam Monitoring System

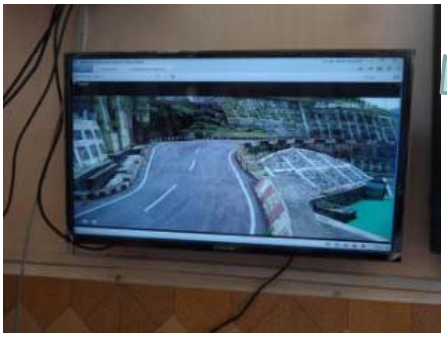
Method of confirmation about CCTV (monitoring camera)

All Camera Clear ?

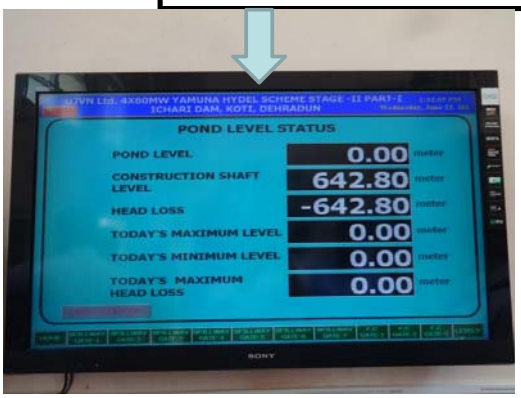
CCTV

SCADA

(Observation Equipment)



Water Level ?



Method of confirmation about Comunication Equipment

Cable phone

Mobile phone

Put a call in to another telephone in office

Put a call in to another telephone in office

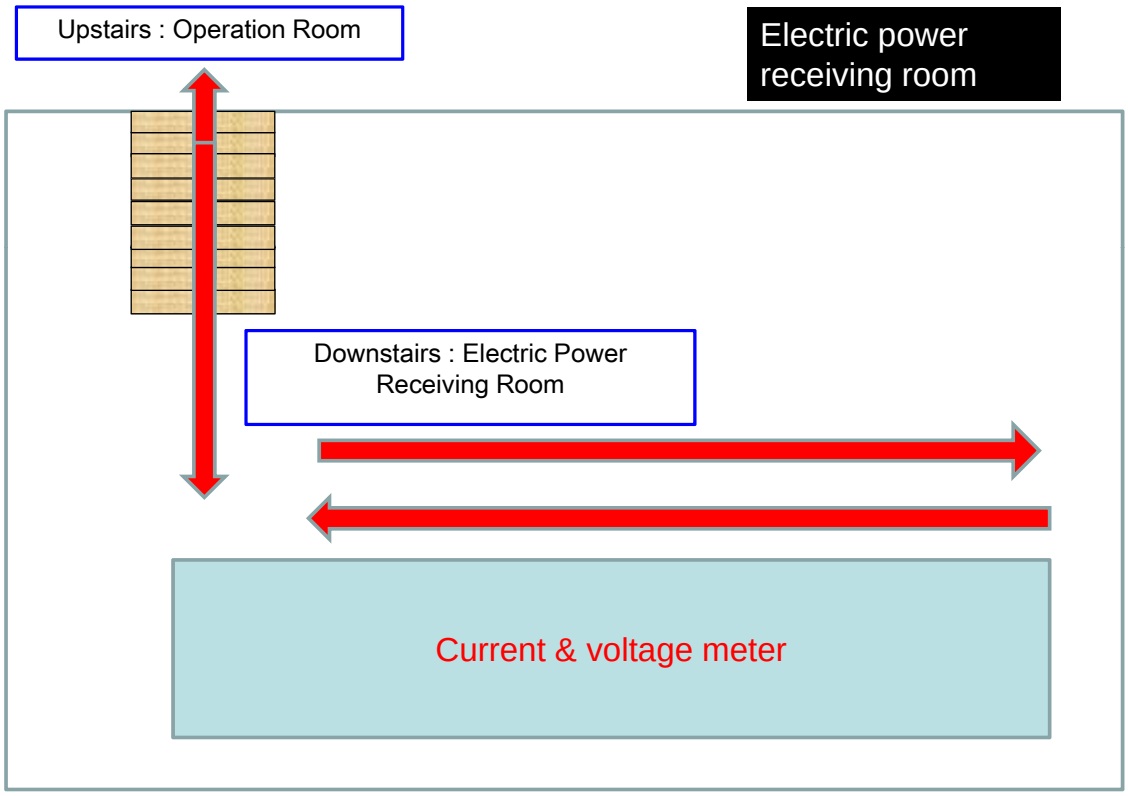
voice call check (Cable line)
(＊＊＊-＊＊＊＊) to intended party

(＊＊＊-＊＊＊＊) voice call check

voice call check
(＊＊＊-＊＊＊＊) to intended party

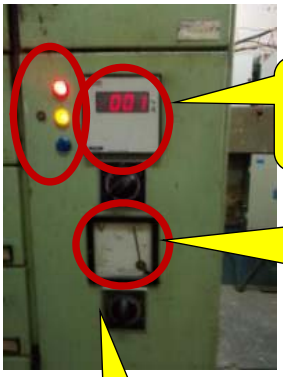
(＊＊＊-＊＊＊＊) voice call check

Direction to Electric power receiving room

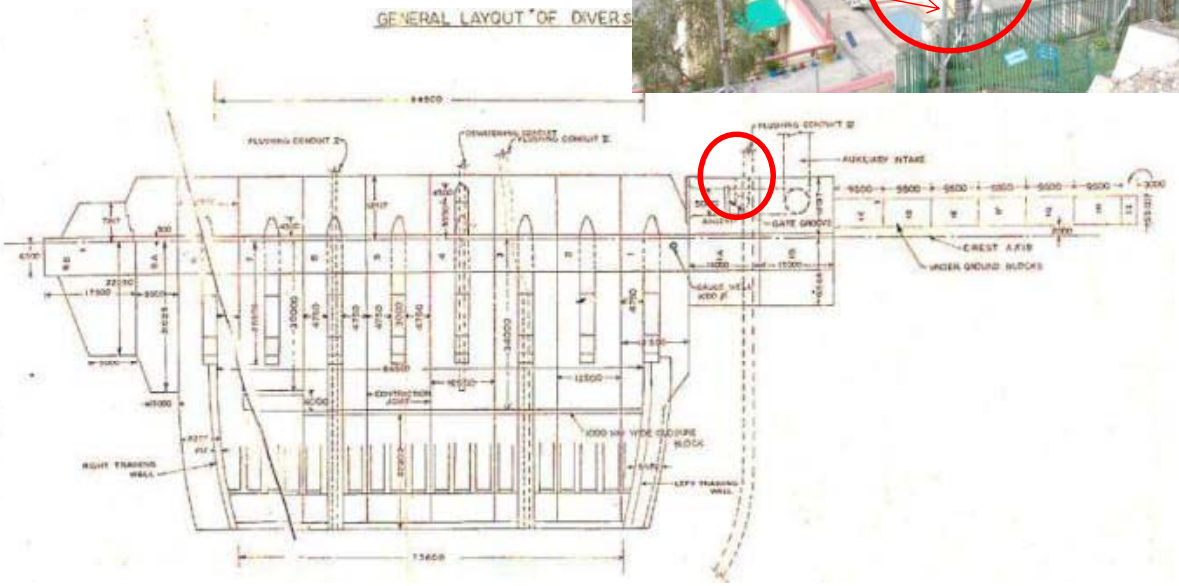


Method of confirmation about power supply

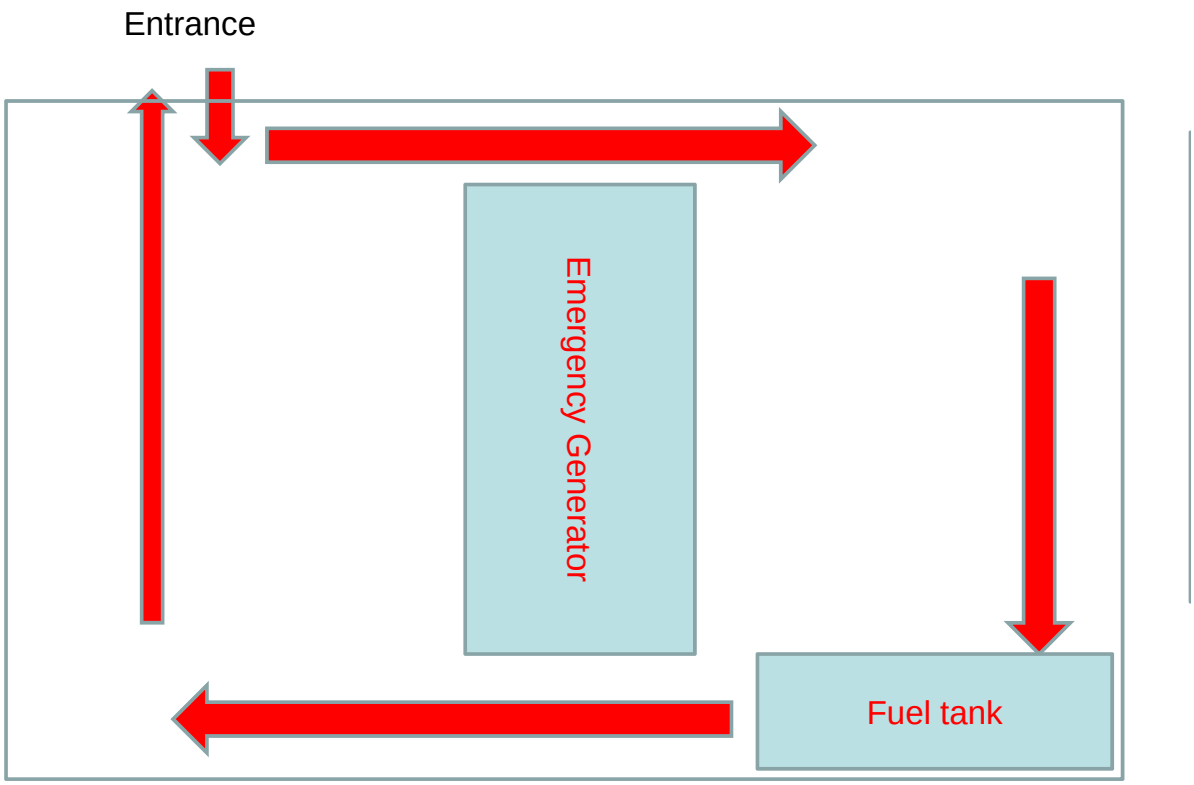
Caution stairs !!



Directions to Emergency Generator Room



Direction to Electric power receiving room



Method of confirmation about Emergency generator

Emergency generator

Leaning / broken of emergency generator
Crack of floor
Leak of oil / liquid on the floor
Starting air, Cooling water, Fuel

Leaning / broken of fuel tank

Leak of fuel on the floor

Fuel tank

Check List

- Fill in column
- Report Executive Engineer urgently!

Ichari Dam

Checklist for initial extraordinary inspection

Electric and Telecommunication equipment

Inspectoin time & date

from : / / to : / /

E & TC	Check items				Procedure	state (✔)	Remarks
Communication Equipment	Wireless communication equipment (ex. micro wave 8.5 GHz)		①	call	Voice Check		
			②	Measuring data check (Received signal level [dBm])	Visual Check		
	Mobile communication equipment (ex. VHF 150 MHz)		①	call	Voice Check		
			②	Measuring data check (Received signal level [dBm])	Visual Check		
	Cable communication		①	call	Voice Check		
Electric power receiving and transforming equipment	Power supply (by electric company)		①	Normal (measuring data check)	Visual Check		
	Emergency generator System	Emergency generator	①	normal (Before test run, Check : fuel, cooling water, starting air)	Test Run/Visual Check		depend on test run time
		Fuel Tank	①	Leaning, Broken, Leak of fuel on the floor	Visual Check		
Electrical equipment	Dam control system		①	Normal (Check display/ panel)	Visual Check		
	Observational equipment (water level, rainfall etc.)		①	Normal (Check display, record)	Visual Check		
	Monitoring camera		①	Normal (Check display/ panel)	Visual Check		
Others							

End

Appendix 7

Drill Scenario

The Consultancy Service for the Preparation of Inspection Manual for Dam Field Engineers after Seismic Events

Drill Scenario

Oct. 2016

Abbreviations

Asst Eng	Assistant Engineer
CWC:	Central Water Commission
DDMA:	District Disaster Management Authority
Deputy GM:	Deputy General Manager
DHD:	Dehradun,
DPT:	Dakpatar,
DRH:	Disaster Response Headquarters
Exec Eng.:	Executive Engineer,
ICD:	Ichari Dam,
IMD:	Indian Meteorological Department,
Jr. Eng.:	Junior Engineer,

1. Objective

1. Once a significant earthquake happens, people will be in panic and hard to exchange damage information correctly. Not only physical damage such as power failure and road cut off but also concentration of telephonic communication may cause secondary trouble which sometimes leads to critical situation.

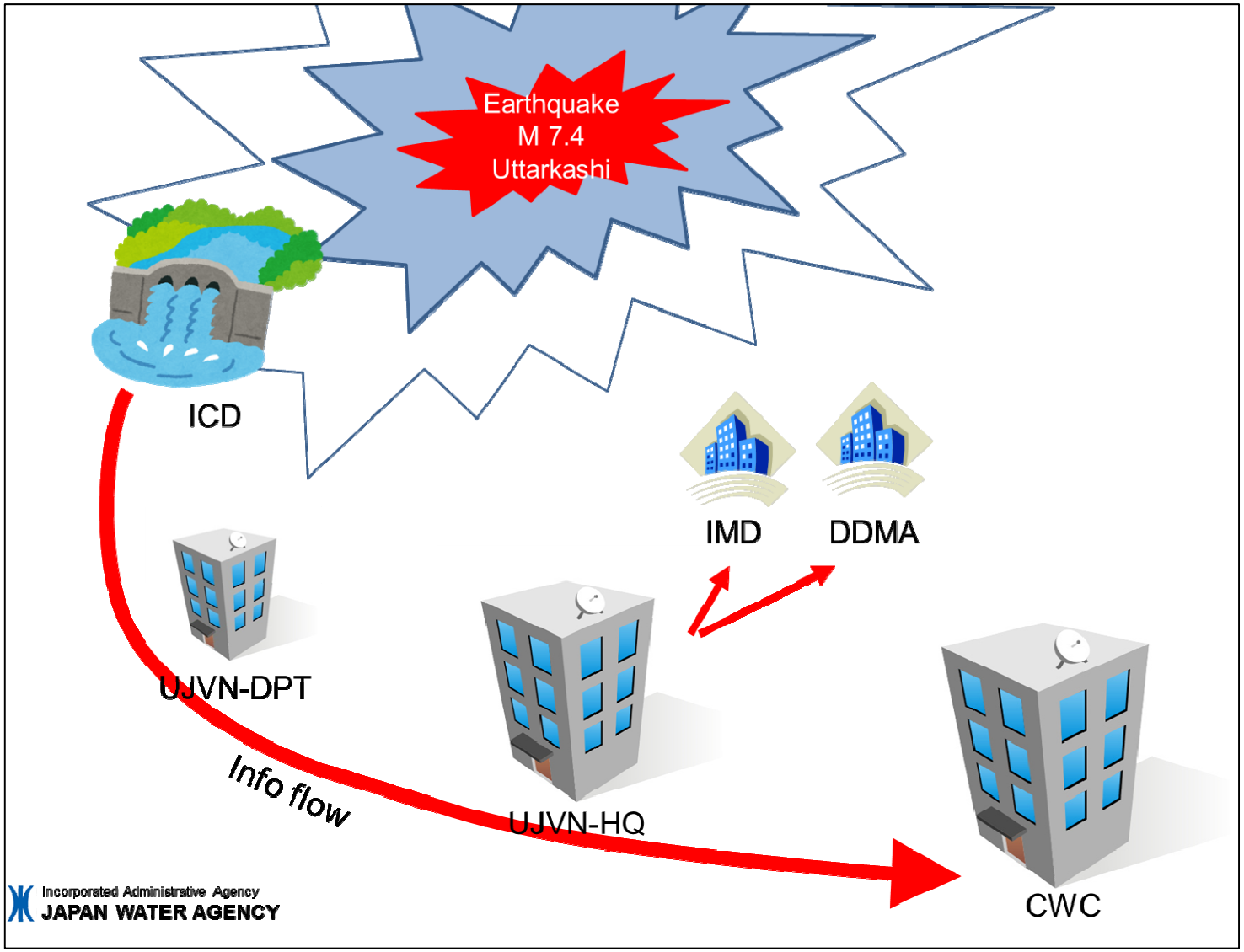
2. On the other hand, a dam with massive stored water is one of the caution needed structures when a significant earthquake has occurred. Avoiding or minimizing any human and economic damages in lower reach is a race against time. In order to collect and disseminate necessary information about damage to the dam even in a panic situation and make a decision for subsequent actions immediately and appropriately, it is essential to establish some scheme to work systematically.

3. The earthquake response manuals and checklists can supports this systematic work, but it is necessary to be revised continuously incorporating social requirement, lessons learned from past experiences, and progress of technology.

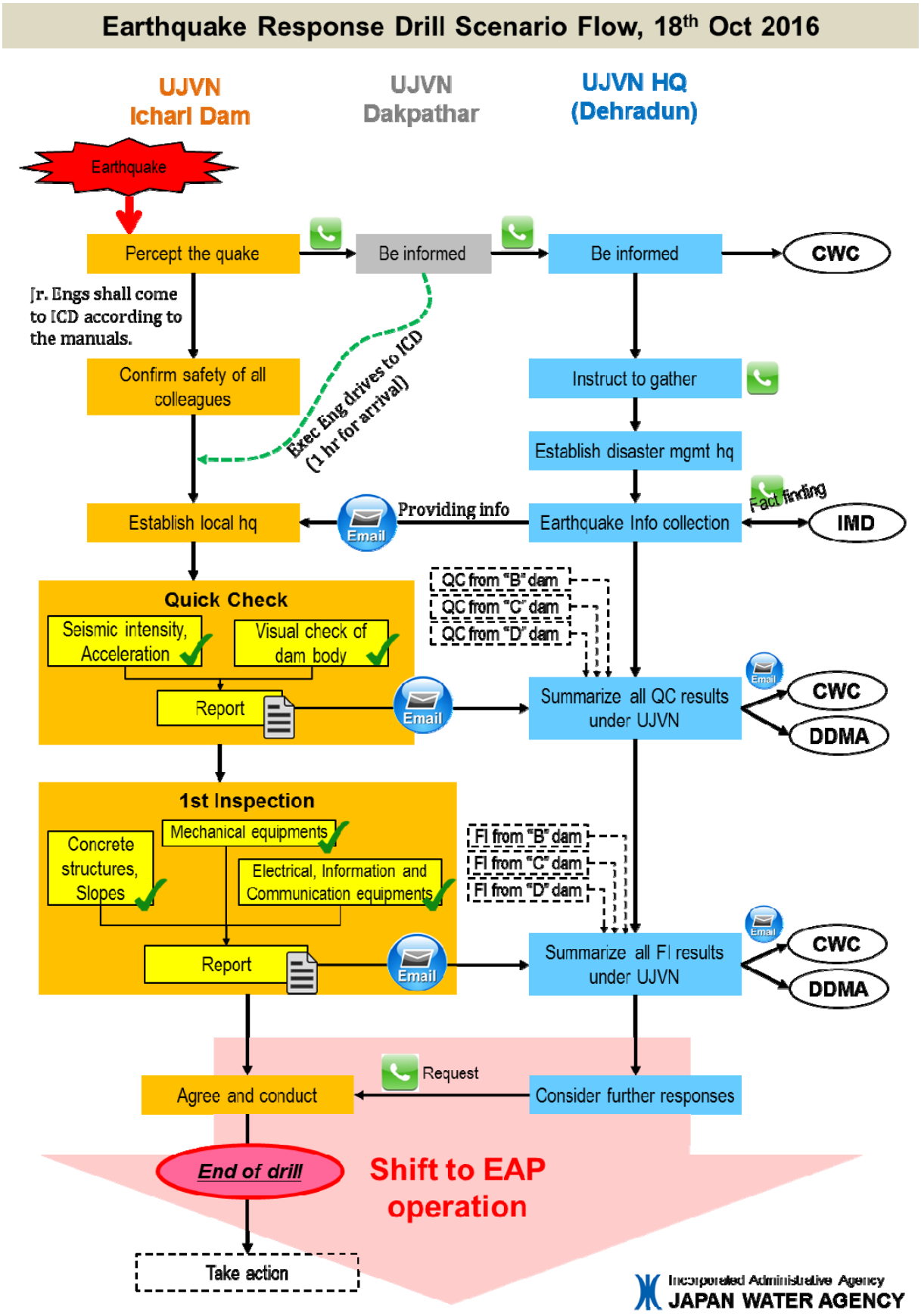
4. The immediate objective of this drill is for all the persons concerned to familiarize earthquake correspondence by following the scenario. After the drill, all the manuals and checklists will be upgraded by incorporating feedbacks from the drill. Through this practice, it is expected that the idea of earthquake response on dams will be spread and further developed in India.

2. Drill outline

Date: 18 October 2016
Venue: Ichari Dam, UJVN Headquarters and the other relevant entities
Participants: officials of CWC, UJVN, Ichari Dam, and Japan Water Agency


Earthquake
M 7.4
Uttarkashi
ICD
IMD
DDMA
UJVN-DPT
UJVN-HQ
CWC
Info flow
Incorporated Administrative Agency
JAPAN WATER AGENCY

Drill image


Earthquake Response Drill Scenario Flow, 18th Oct 2016
UJVN Ichari Dam
UJVN Dakpathar
UJVN HQ (Dehradun)
Earthquake
Percept the quake
Be informed
Be informed
CWC
Jr. Engs shall come to ICD according to the manuals.
Confirm safety of all colleagues
Exec Eng drives to ICD (1 hr for arrival)
Instruct to gather
Establish disaster mgmt hq
Establish local hq
Email
Providing info
Earthquake Info collection
Fact finding
IMD
Quick Check
Seismic intensity, Acceleration
Visual check of dam body
Report
Email
QC from "B" dam
QC from "C" dam
QC from "D" dam
Summarize all QC results under UJVN
Email
CWC
DDMA
1st Inspection
Concrete structures, Slopes
Mechanical equipments
Electrical, Information and Communication equipments
Report
Email
FI from "B" dam
FI from "C" dam
FI from "D" dam
Summarize all FI results under UJVN
Email
CWC
DDMA
Request
Agree and conduct
Consider further responses
End of drill
Shift to EAP operation
Take action
Incorporated Administrative Agency
JAPAN WATER AGENCY

Drill flow

3. Drill Scenario

Time	Events and actions	Report from who to whom		Discussion point
		From	to	
9:00	M7.4, epicenter at Uttarkashi (63km from Ichari)	-		
9:05	Jr. Eng. at ICD reports to Exec. Eng, at DPT that he felt a strong quake now. ***"This is a drill. I felt a strong quake just now. Currently, ## staff members are on duty, but their safeties have not yet been confirmed."*** All Jr. Eng. need to come to the ICD after confirming their families' safety. Then, Jr. Eng will confirm safety of all his colleagues.	UJVN-ICD Post: Jr. Eng. Name: (on duty at that time)	UJVN-DPT Post: Exec Eng. Name: Mohd Afzal	
9:10	Exec Eng reports to UJVN headquarters ***"This is a drill. It was reported that there had been a significant quake at ICD. I also felt at DPT. I am departing for ICD now and will arrive one hour later."***	UJVN-DPT Post: Exec Eng. Name: Mohd Afzal	UJVN-HQ Post: Exec Eng. Name: Rejsh Kumar Nantigal	
9:15	Exec Eng call to Asst Eng: ***"This is a drill. It was reported that there had been a significant quake at ICD. I am departing for ICD with you.*** *(then, confirm meeting point and timing)"*	UJVN-DPT Post: Exec Eng. Name: Mohd Afzal	UJVN-DPT Post: Asst Eng. Name: Bhanu Joshi	
9:15	The recipient calls all members for emergency response to the headquarters. ***"This is a drill. There seemed to be a significant earthquake at north Uttarakhand. Please come to the headquarters immediately."***	UJVN-HQ Post: Exec Eng. Name: Rejsh Kumar Nantigal	UJVN-HQ Post: Deputy GM Name: Vivek Atrey	This time, only two persons will undertake a duty of disaster mgmt at UJVN-HQ.
9:20	The recipient informs CWC as well. "***This is a drill. There seemed to be a significant earthquake at north Uttarakhand. We are going to establish disaster response headquarters (DRH) in the UJVN-HQ building."***	UJVN-HQ Post: Deputy GM Name: Vivek Atrey	CWC Post: Chief Eng., Dam Safety Org. Name: N.K. Mathur	This time, the DRH will be established at ICD temporally, but it should be in UJVN-HQ normally.

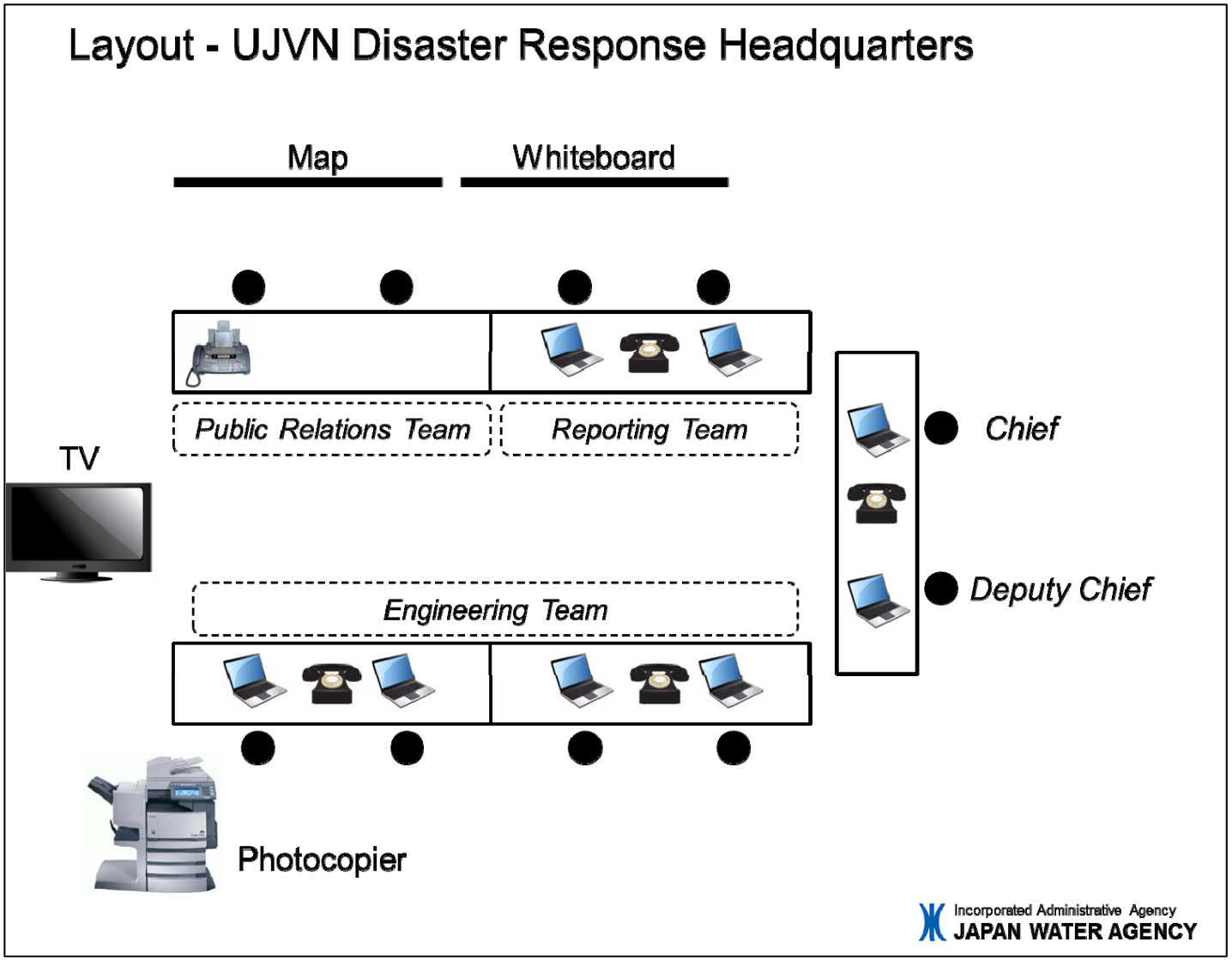
10:00	(all members are assembled at UJVN-HQ) (Start setting up the disaster response headquarters) ➢ The DRH is established when the chief of headquarters declared. After that, all information is sent to the chief and DRH members are required to work following the instruction of the chief in principle. ➢ The image of DRH is in the last page of this document.	-	-	CWC and UJVN-HQ need to arrive at ICD before this timing.
10:00	UJVN-HQ contacts to IMD. Desktop Deputy GM: ***"Please let us be informed about the earthquake"*** ***"The magnitude is 7.4 and epicenter is at Uttarkashi. You must be careful about aftershock for at least one week.***	UJVN-HQ Post: Deputy GM Name: Vivek Atrey	IMD Post: Name:	
10:10	UJVN-HQ informs to DPT and ICD about earthquake. Deputy GM: ***"This is a drill. Please be advised that the magnitude was 7.4 and epicenter was at Uttarkashi. You must be careful about aftershock for at least one week.***	UJVN-HQ Post: Deputy GM Name: Vivek Atrey	UJVN-DPT Post: Exec Eng. Name: Mohd Afzal	Exec Eng receives this info on his way to ICD.
10:20	(all members are assembled at CWC) (Start setting up the disaster response headquarters)	- CWC	- CWC	
10:20	(Exec Eng. /Asst. Eng. arrives at ICD)	-	-	
10:20	Exec Eng instructs Asst Eng: ・ To check safety of staff members ・ To instruct implementation of Quick Check. The ICD staff will be divided into three teams (but it is up to Asst Eng.) Team for reporting Team for seismometer Team for ICD outlook check	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	UJVN-ICD Post: Asst Eng. Name: Bhanu Joshi	

	Then, each team picks up the manual, checklist and required tools.			
10:40	Asst Eng requests Exec Eng to confirm the report contents and send out by e-mail. ✓ Acceleration: X: 100 cm/sec^2 Y: 110 cm/sec^2 Z: 30 cm/sec^2 3 components: 150 cm/sec^2 ✓ Seismic Intensity: 10 (MSK scale) ✓ All the staff members are in safe. ✓ No severe damage on the road for Dam site ✓ No damage on dam body at first sight	UJVN-ICD Post: Asst Eng. Name: Bhanu Joshi	UJVN-HQ Post: Deputy GM Name: Vivek Atrey Post: Exec Eng. Name: Rejsh Kumar Nantigal	
10:45	ICD Exec Eng confirms arrival of the Quick Check report. ***"This is a drill. I send the Quick Check report to the headquarters. Please let me know its arrival"***	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	UJVN-HQ Post: Deputy GM Name: Vivek Atrey	It would be better for all to have a business manner to reply immediately for just informing the arrival of e-mail or facsimile.
10:50	Exec Eng instructs Asst Eng to begin the first inspection. The ICD staff will be divided into three teams (but it is up to Asst Eng.) Team for reporting Team for structural inspection Team for mechanical inspection Team for electrical inspectrion Each team picks up the manual, checklist and required tools.	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	UJVN-DPT Post: Asst Eng. Name: Bhanu Joshi	
10:55	Deputy GM at UJVN-HQ forward to CWC and DDMA after checking the contents of report. (In the real case, the HQ will collect information of all dams under UJVN and send out.) Deputy GM confirms arrival of the Quick Check report to recipients.	UJVN-HQ Post: Deputy GM Name: Vivek Atrey	CWC Post: Chief Eng., Dam Safety Org. Name: N.K. Mathur	

	"This is a drill. I send the Quick Check report to CWC (or DDMA). Please let me know its arrival"		Post: Director, Dam Safety Rehabilitation Name: Pramod Narayan DDMA Post: Name:	
11:40	Asst Eng requests Exec Eng to confirm the result of the First Inspection and sends out. Note) Before this timing, the Exec Eng needs to catch the inspection results intermittently.	UJVN-ICD Post: Asst Eng. Name: Bhanu Joshi	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	
11:50	The report of inspection result is sent to UJVN-HQ. i) Leakage from a joint at bottom-left of gallery and drainage at bottom-right gallery seem to have increased. ➢ About the drainage pump at the bottom, it seems like the interval between off and on has shortened. ➢ Nothing turbid in the drained water ii) Also leakage from a crest gate seems to have increased iii) The display for reservoir level disappeared. As a result, actual water level is unknown. iv) Higher turbidity than usual was observed in the reservoir. v) Collapse of slope in the upper part made the road closed. vi) No damage on the dam body and spillway gates and electric system	UJVN-ICD Post: Asst Eng. Name: Bhanu Joshi	UJVN-HQ Post: Deputy GM Name: Vivek Atrey Post: Exec Eng. Name: Rejsh Kumar Nantigal	
12:00	Deputy GM at UJVN-HQ forwards the report to CWC and DDMA. (This also will be sent after collecting all info of UJVN dams in reality.)	UJVN-HQ Post: Deputy GM	CWC Post: Chief Eng.,	

		Name: Vivek Atrey	Dam Safety Org. Name: N.K. Mathur Post: Director, Dam Safety Rehabilitation Name: Pramod Narayan DDMA Post: Name:	
12:10	Deputy GM at UJVN-HQ instructs ICD that: • Reservoir level shall be recorded by reading the fixed water gauge every three(?) hours, but only during day time, until the system is recovered • The cause of disappearance shall be investigated. • The turbidity in the reservoir shall be carefully observed once a day.	UJVN-HQ Post: Deputy GM Name: Vivek Atrey	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	
12:15	Exec Eng instructs Asst Eng that: • **Implement** Reservoir level at the water gauge shall be immediately checked and reported to him. • **Implement** Turbidity as well. • **Desktop** The cause of disappearance shall be investigated and consider solution.	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	UJVN-ICD Post: Asst Eng. Name: Bhanu Joshi	
12:20	Deputy GM at UJVN-HQ provide second instruction to ICD that: • **Desktop** The behavior of drainage pump shall be paid attention and the next 24 hours operation data of drainage pump with the past one shall be sent to the headquarters. • If an interval of drainage pump work would become shorter than previous one, leakage within the inspection gallery shall be checked immediately.	UJVN-HQ Post: Deputy GM Name: Vivek Atrey	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	

12:25	Exec Eng instructs Asst Eng that: • The behavior of drainage pump shall be monitored carefully. Particularly, the interval of its work shall be recorded precisely. • The past data of drainage pump work shall be prepared for sending to the headquarters. • If an interval of drainage pump work would become shorter than previous one, leakage within the inspection gallery shall be checked immediately.	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	UJVN-ICD Post: Asst Eng. Name: Bhanu Joshi	
12:30	Deputy GM at UJVN-HQ provide second instruction to ICD that: • The gate which seemed to increase leakage shall be tested by once fully opening and closing with setting the guard gate. • However, it should be carried out after next week in consideration of the leakage in the gallery and aftershocks.	UJVN-HQ Post: Deputy GM Name: Vivek Atrey	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	
12:35	Exec Eng instructs Asst Eng that: • The staff needs to prepare the emergency test of opening and closing gate which will be carried out after next week. • The other gates need to be checked once a day if there will be any changes.	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal	UJVN-ICD Post: Asst Eng. Name: Bhanu Joshi	
	(lunch time)			
14:00	Evaluation meeting at ICD (feedback only from ICD staff members)	-		



Disaster response headquarters image

The list of Participants for the field drill

SN	Name	Position	
	CWC		
1	N. K. Mathur	Chief Engineer, Dam Safety Organization	
2	Pramod Narayan	Director, Dam Safety Rehabilitation	
	UJVN-HQ		
3	Vivek Atreya	Deputy General Manager	
4	Rajesh Kr Nautiyal	Executive Engineer	
	Ichari Dam & Dakpathar office		
5	Muhammad Afzal	Executive Engineer	Electric ， Telecommunication and Mechanical (E&M)
6	Dharmendra Singh	Executive Engineer	Civil Engineering (Civil)
7	Bhanu Parkash （Joshi)	Assistant Engineer	E&M
8	Pankaj Kumar	Assistant Engineer	Civil
9	Bhagwan Parshad	Jr. Engineer	E&M
10	Rudrara Ram	Jr. Engineer	E&M
11	Suresh lal	Jr. Engineer	E&M
12	Santram	Operator	E&M
13	Dharam Singh	Operator	E&M
14	Dataram	Operator	E&M
15	Atar Singh	Operator	E&M
16	Tulsiram	Operator	E&M
17	Khajan Singh	Operator	E&M

Appendix 8

Records of the Drill

DRIL

Report on earthquake response of Ichari dam	Date: 18/10/2016 Serial No. 01

Report on extraordinary inspection

Following are the result of quick inspection after the earthquake

Inspection result

Dam body No Deformation

Surrounding moutains ok

Gates and volves ok

Others ok.

State of the earthquake or flood	
Event date & time:	: 18/10/2016 10:20
Event location:	Ichari Dam
Seizmic Intensity at nearest point:	Ichari Dam
Observed Accelaration	X= 100 gal, Y= 110 gal, Z= 30 gal

Signature for confirmation

Task force in field

Head	Staff	Officer in charg	Dispatch date & time
	P.K. Panwar		10:25 : ,18/10/2016

Emergency Response Headquarters

	Chief	Deputy Chief	group leader	Officer in charg
HQ		18/10/2016		

Ichari dam

Checklist for extraordinary inspection (First Check) **DRILL**

Structures

Inspection time & date

from : 18/10/16 (10:40 AM) to : 18/10/16 (11:40 AM)

Name of inspector Dharmendra Singh

Structures				Check items	State
Dam	Body	Upstream face	1	Leakage, Crack (visually observe or camera)	No major leakage or crack observed.
		Downstream face (Spillway section)	2	Leakage, Crack (visually observe or camera)	No major crack observed. Minor leakage from 3, 4, 5 & 6 no spillway observed.
		Downstream face (Non-spillway section)	3	Leakage, Crack (visually observe or camera)	No major leakage / cracks observed
		Gallery	4	Leakage, Crack (visually observe or camera)	Minor leakages observed.
		Bridge (Crest)	5	Collapse, Deformation (visually observe or camera)	No collapse, deformation found.
	Others	Control room	6	Crack, any failure (visually observe or camera)	No crack, failure observed.
		Staff room, Labs, Washroom	7	Crack, any failure (visually observe or camera)	No crack, failure observed.
		Construction shaft	8	Crack, any failure, water situation (muddy, lowering) (visually observe or camera)	No crack, failure observed.
		Intake tower	9	Crack, any failure (visually observe)	No crack, failure observed.
		Bridge (Access road)	10	Collapse, Deformation (visually observe or camera)	No collapse, deformation observed.
		Bridge (Gate section)	11	Collapse, Deformation (visually observe or camera)	No collapse or deformation observed
		Bridge (Flushing gate 1,2)	12	Collapse, Deformation (visually observe or camera)	No collapse or deformation observed

18/10/16

P.K. Panwar

(11:45 AM) Ex. Incharge Ichari Dam

			No.		
Around reservoir		Bridge (Flushing gate 3)	13	Collapse, Deformation (visually observe or camera)	No collapse, deformation observed.
		Railing and fencing	14	Deformation (visually observe or camera)	No collapse, deformation observed
	Moutains	Right bank	15	Collapse, Land slide (visually observe or camera)	No collapse, Land slide observed
		Left bank	16	Collapse, Land slide (visually observe or camera)	Minor land slide observed.
	Roads	Road on right bank	17	Slopes, retaining walls (camera)	Few cracks on the road found.
		Road on left bank	18	Slopes, retaining walls (camera)	No major slope failure. Few Minor cracks on retaining walls found.
	Reservoir	Slope	19	Collapse, Land slide (Camera)	No collapse. Few minor cracks observed.
		Inflow of the river	20	Change inflow pattern, reservoir water level (visually observe or camera)	No change observed.
	River	Downstream protection works	21	Collapse, Deformation (visually observe or camera)	Everything found ok.

Note: Slight increase in turbidity was also observed.

P.K. Parmar

EE (11:45 AM)

Ex. Incharge Ichari Dam 11:45

18/10/16

Ichari Dam

Checklist for initial extraordinary inspection
Mechanical equipment

DRILL

Implementation Date 18/10/16 Time 10:37 ~ Date 18/10/16 Time 11:30

Name Bhanu Joshi, AE (Ichari Dam)

Name of Equipment		Check Item	Procedure	State																		Reference
				Spillway Gate							FC gates			TCS		Dewatering Gate	Auxiliary Gate	Intake Gate				
				#1	#2	#3	#4	#5	#6	#7	#1	#2	#3	#1	#2	#1	#1	#1	#2	#3	#4	
Gates	Opening and Closing Equipment, Wire rope	Leaning	Visual Check	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		Leak of oil	Visual Check	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Local operation board	Leaning	Visual Check	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		lighting position (normal / abnormal), Leaning	Visual Check	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Operation Board	Leaning	Visual Check	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		Abnormarity display	Visual Check	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Gate and gate stop	Crack or deformation	Visual Check	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		Leakage	Visual Check	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Inspection Boat			Visual Check	✓																		
Elevator		Don't Use(Sign Board)																				
Drainage Pump	Local operation board	Leaning	Visual Check	✓																		
	Drainage	Drainage Water from drain outlet	Visual Check	✓																		

Remark X Leakage from Spillway Gate No-01 seems to have increased from bottom side.

18/10/16

BTP 18/10/16 AE (E&M) Ichari Dam

Executive Engineer 18/10/16 Ichari Dam 11.40 hrs

Ichari Dam

Checklist for initial extraordinary inspection

Electric and Telecommunication equipment

DRILL

Inspectoin time & date 10:37 hrs, 18-10-16

from : 10 / 37 / 00 **to** : 11 / 35 / 00

E & TC	Check items				Procedure	state (✓)	Remarks
Communication Equipment	Wireless communication equipment (ex. micro wave 8.5 GHz)		①	call	Voice Check	—	
			②	Measuring data check (Received signal level [dBm])	Visual Check	—	
	Mobile communication equipment (ex. VHF 150 MHz)		①	call	Voice Check	✓	
			②	~~Measuring data check~~ (Received signal level [dBm])	Visual Check		
	Cable communication		①	call	Voice Check	✓	
Electric power receiving and transforming equipment	Power supply (by electric company)		①	Normal (measuring data check)	Visual Check	✓	
	Emergency generator System	Emergency generator	①	normal (Before test run, Check : fuel, cooling water, starting air)	Test Run/Visual Check	✓	depend on test run time
		Fuel Tank	①	Leaning, Broken, Leak of fuel on the floor	Visual Check	✓	
~~Electrical equipment~~ Information	Dam control system		①	Normal (Check display/ panel)	Visual Check	×	The display for [illegible] level [illegible] Actual water level [illegible] (Pb-sto)
	Observational equipment (water level, rainfall etc.)		①	Normal (Check display, record)	Visual Check	✓	
	Monitoring camera		①	Normal (Check display/ panel)	Visual Check	✓	
Others							

[signature] 18/10/16

[signature] B. P. Joshi AE (E&M) Ichari Dam

[signature] Er. [illegible] 18/10/16 Ichari Dam 11:40 hrs

Attached Photo 1　Upstream of Dam (Data Capacity 4.7MB)

Attached Photo 2 Downstream of Dam (Data Capacity 4.5MB)

Attached Photo 3 Monitor (Data Capacity 2.8MB)

Appendix 9

Materials of Post Drill Work Shop

Agenda of the Post Drill Work Shop

Objective

The titled workshop aims to share the knowledge on dam safety in Japan with all engineers in charge of dam safety in different dam utilities of Uttrakhand and to think back the drill result for further improvement of earthquake response.

Date:20th October

Venue: Board Room at UJVNL HQ-Ujjwal, Maharani Bagh,G.M.S.Road,Dehradun-248006

Date/Time	Content	Remarks
10:00-10:05	Welcome by Mr. Sanjaya Mittal, General Manager (Yamuna Valley)	UJVN Ltd.
10:05-10:10	Opening remark by Mr. S.N.Verma, Managing Director	UJVN Ltd.
10:10-10:15	Address by Dr. Umakant Panwar, Principal Secretary (Energy)	Department of Energy, GoU.
10:15-10:20	Brief on the necessity of preparation of Inspection Manual by Mr. B.C.K.Mishra, Director (Operations)	UJVN Ltd.
10:20-11:00	Dam safety and Disaster Management in Japan	Dr. Kentaro KIDO, JWA
11:00-11:10	Questions & Answers	
11:10-11:30	Tea Break	
11:30-11:50	Management Policy on Electric, Information, Telecommunication and Mechanical Facilities for Dam O&M	Dr. Masahiro SUGIURA, JWA
11:50-12:00	Questions & Answers	
12:00-12:20	Practicing earthquake response drill at Ichari dam and lessons learned	Mr. Nobuyuki ICHIHARA, JWA
12:20-12:30	Questions & Answers	JWA team
12:30-13:00	Address by eminent speakers of participating dam utilities	All participants
13:00-14:00	Lunch	
14:00-14:20	Recommendations from JWA's Experiences	Mr. Tatsuo KUNIEDA, JWA
14:20-14:55	Questions & Answers, Further feed back	
14:55-15:00	Vote of Thanks	

Dam Safety and Disaster Management in Japan

20th October, 2016

Kentaro KIDO Ph.D.

Japan Water Agency

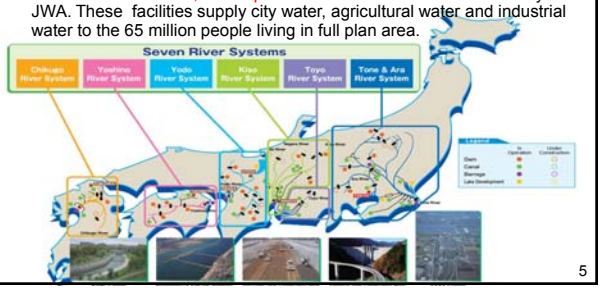
trust funded and administrated by

Contents

1. Outline of Japan Water Agency (JWA)

JWA's Projects

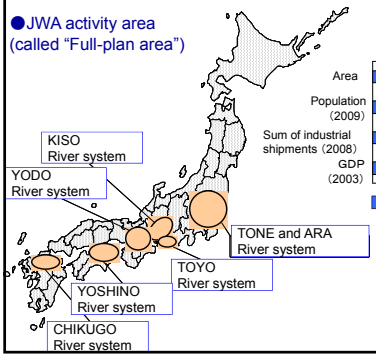
- ✓ JWA is a River Basin Organization and has contributed to water resources management based on the Basic Plan for Water Resources Development for more than 50 years in Japan.
- ✓ JWA has been constructing, operating and reconstructing water resources management facilities for water use and flood control such as dams, weirs and canals.
- ✓ 43 Dams and about 1,000km primal water route were established by JWA. These facilities supply city water, agricultural water and industrial water to the 65 million people living in full plan area.



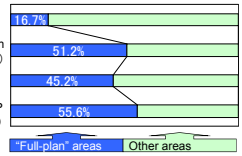
JWA's Share in Japan

■JWA activity areas are seven river basins where "Water Resources Development Basic Plan" is stipulated.

●JWA activity area (called "Full-plan area")



●The share of Full plan area in Japan



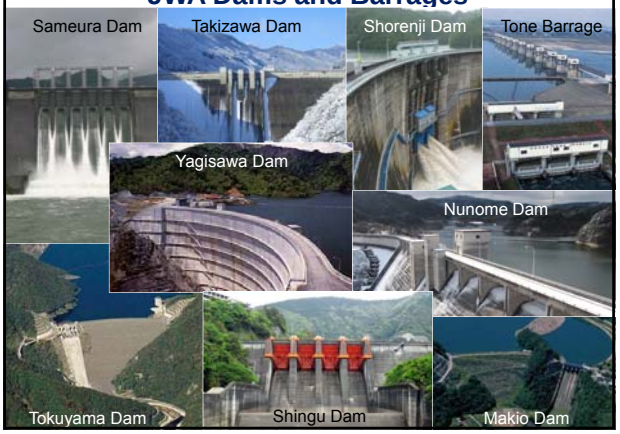
Only 17% of the national land area, but about 50% of the population and industrial output are concentrated there.

Major JWA Dams

Name	Type	Height (m)	Crest Length (m)	Reservoir Capacity (X1,000m3)	Completion Year
Tokuyama	R	161.0	427	660,000	2008
Naramata	R	158.0	520	90,000	1990
Urayama	PG	156.0	372	58,000	1998
Kusaki	PG	140.0	405	60,500	1976
Misogawa	R	140.0	447	61,000	1996
Takizawa	PG	132.0	424	63,000	2010
Yagisawa	A	131.0	352	204,300	1967
Shimokubo	PG	129.0	605	130,000	1968
Iwaya	R	127.5	366	173,500	1976
Tomisato	PG	106.0	250	52,000	2000
Sameura	PG	106.0	400	316,000	1977

R: Rock fill PG: Concrete gravity A: Concrete arch

JWA Dams and Barrages



JWA's Technologies

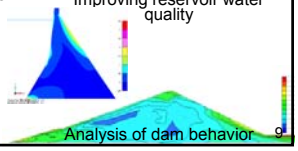
- ✓ JWA has been serving to lead in water resources development and management in Japan with advanced technologies of the water resources management facilities,.
- ✓ Those skills have been fully reflected in appropriate operation and maintenance of those facilities, preventing measures for deteriorating facilities, and environmental preservation measures.


Construction of dam body


Integrated operation of canal system


Improving reservoir water quality


Inspection of dam/canal facilities


Analysis of dam behavior

Contribution in International Cooperation

➢ Network of Asian River Basin Organizations (NARBO)

- ✓ NARBO was established in February 2004 by JWA, ADB and ADBI to promote integrated water resources management (IWRM) in monsoon areas of Asia.
- ✓ NARBO members: 86 organizations from 18 countries
- ✓ Major Activities: Information sharing, thematic workshops, twinning program, IWRM training and RBO performance benchmarking.

➢ Dispatch of Experts

- ✓ JWA has dispatched many long-term and short-term experts requested by JICA or other organizations.
- ✓ JWA has contributed to International Emergency Aid Group or other emergency dispatch at disasters.

➢ Consulting Works

- ✓ JWA has performed consulting works such as planning, survey and design for enhancement of water management of Asian countries.

Objective of This Mission

- providing operation and maintenance methods during/after the seismic activities, and draft manuals and check lists of the activities needed to be performed after the seismic activities from the dam safety view points for field engineers under DRIP.

2. Dam Safety Inspection in Japan

Dam Safety Inspection Scheme

Dam Safety Inspection in Japan

Inspection by Dam Owner

Usual Inspection
- Daily
- Monthly
- Yearly

Extraordinary Inspection
- After flood hit
- After earthquake occurred

Comprehensive Inspection
- Every 30 years

Inspection by External Specialist

Periodic Inspection
- Every 3 years

Inspection Items for Each Dam Type

Article 13 of Cabinet Order concerning Structural Standards for River Management Facilities, etc.

Dam type		Height	Inspection item
Concrete Gravity Dam		Less than 50 m	Leakage, Uplift
		50 m or more	Leakage, Uplift, Deformation
Concrete Arch Dam		Less than 30 m	Leakage, Deformation
		30 m or more	Leakage, Deformation, Uplift,
Embankment Dam	Uniform type		Seepage, Deformation, Saturated line
	Zone type		Seepage, Deformation

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Standard for Inspection Items and Frequencies

Management Category		Dam type	Inspection Items and Frequencies			
			Leakage Seepage	Uplift	Deformation	Patrol
1st period	Test submerging	Concrete dam	Once a day	Once a day	Once a day	Once a day
		Embankment dam			Once a week	
2nd period	At least 3 years after the 1st period	Concrete dam	Once a week	Once a week	Once a week	Once a week
		Embankment dam			Once a month	
3rd period	After the 2nd period	Concrete dam	Once a month	Once a month	Once a month	Once a month
		Embankment dam			Once in three months	

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3. Measurements of Dam Behavior for Safety Evaluations

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Safety Evaluation of Dam

Evaluation items

by monitoring data;
- •Deformation of dam body
- •Leakage/Seepage from dam body and foundation
- •Uplift pressure under dam body (*Concrete dam)

by visual observation;
- •Deformation of surface of dam body (*Fill type dam)
- •Deformation of abutment slope
- •Deterioration of concrete; cracking, ageing, etc.
- •Leakage/Seepage from dam body and foundation; turbid or not?

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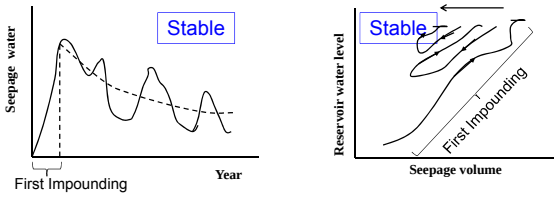
Evaluation of measurements of dam behavior

1. Type of the changes of dam behavior as time proceeds
2. Correlation between the external impact factor



3. Peculiar behavior in overall data
4. Difference compared to other dams' behaviors

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Extraordinary inspection immediately after earthquake

•Extraordinary inspection upon an earthquake
- −No.1 alert formation: **Intensity 4, or 25 cm/s^2** or more at the dam foundation
- −No. 2 alert formation: Intensity 5, or 80 cm/s^2 or more at the dam foundation

•1st Inspection Report : to be made within 3 hrs
•2nd Inspection Report: to be made within 24 hrs including quick report of inspection, leakage/Seepage, deformation etc.
•If during night time, 2nd IR can be made next morning


The seismometer in gallery


Display of seismometer

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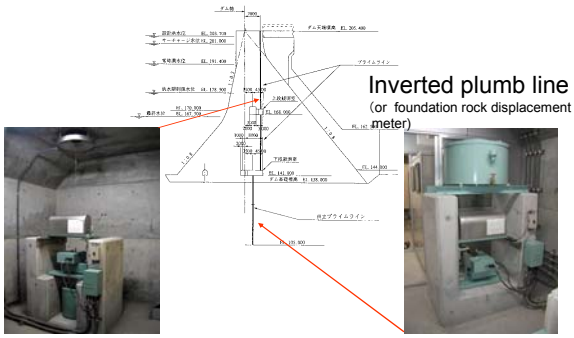
4. Evaluation Items of Concrete Dam Body

- Deformation of dam body
- Leakage from dam body and foundation
- Uplift pressure under dam body
- Deterioration of concrete

Deformation of Concrete Dam

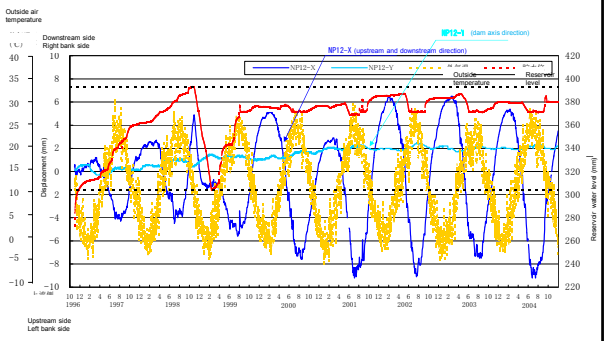


Inverted plumb line
(or foundation rock displacement meter)

Normal plumb line (or dam deflection meter)

Deformation of Concrete Dam

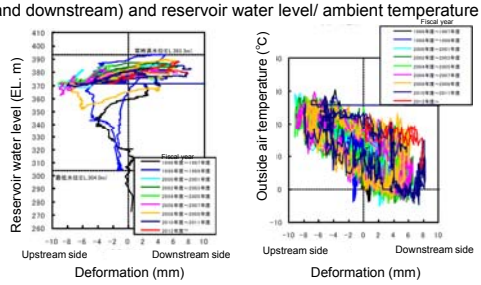
- An example of secular change -



Deformation of Concrete Dam

- An example of correlation diagram -

Relationship between X (Deformation in the direction of upstream and downstream) and reservoir water level/ ambient temperature



Decrease in reservoir water level/ Rise in temperature
→ Displacement of dam body in the direction of upstream side

Leakage from concrete dam body / foundation

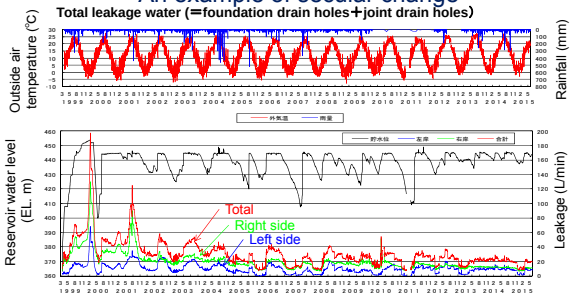
Foundation drain hole

Joint drain hole

Triangular weir

Leakage from concrete dam body / foundation

- An example of secular change -



○Year to year tendency: gradually decreasing in general（Clogging on the leakage path）

○Reservoir water level rise → Leakage volume increase
○Ambient temperature (dam body temp.) drop → Leakage volume increase

Uplift Pressure

Bourdon pressure gauge

Pore pressure meter*

*Embedded meter tend to lose measuring capability after 20 years .

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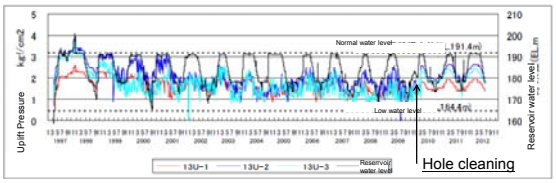
Uplift Pressure
- An example of secular change -



- Uplift pressure tends to drop with the passage of time
- Uplift pressure tends to up after 2010.
- It was caused by cleaning of foundation drain holes.

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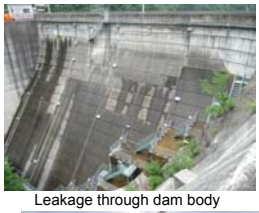
Deterioration of Concrete



Leakage through dam body

Alkali-Silica Reaction

Drying shrinkage / Thermal crack

Crack by large-scale earthquake

Frost attack

Abrasion

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5. Response to Earthquake

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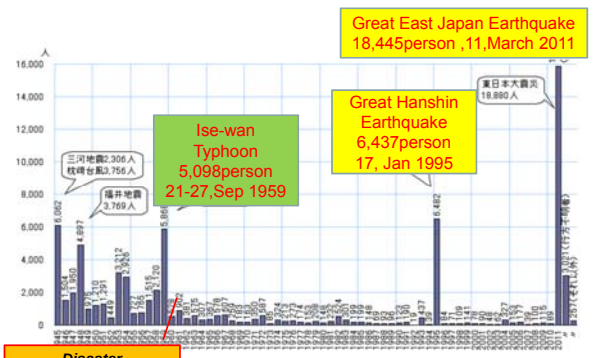
Historical Disaster in Japan



Disaster Countermeasure Basic Act

The number of Casualties

Source : Ministry of Land , Infrastructure, Transport and Tourism (MLIT)

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Technological Assistance for Quick Response

JSI: Japanese seismic intensity

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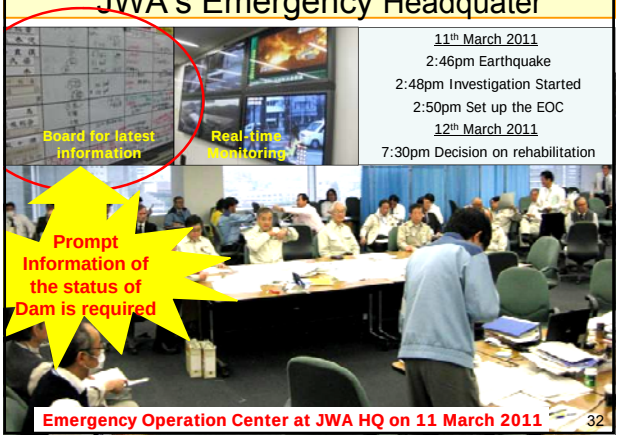
JWA's Emergency Headquater



11th March 2011
2:46pm Earthquake
2:48pm Investigation Started
2:50pm Set up the EOC
12th March 2011
7:30pm Decision on rehabilitation

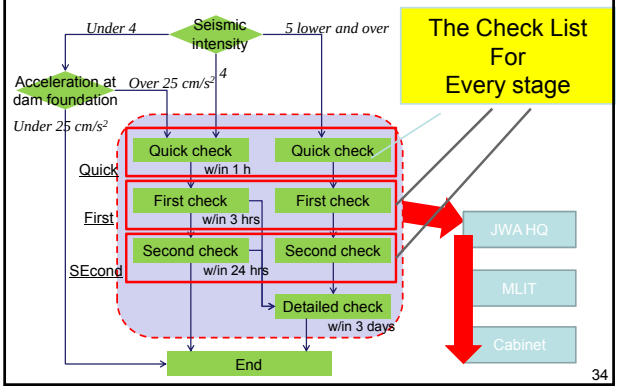
Emergency Operation Center at JWA HQ on 11 March 2011

Dam Safety Inspection Scheme

Dam Safety Inspection in Japan

- **Inspection by Dam Owner**
  - **Usual Inspection**
    - Daily
    - Monthly
    - Yearly
  - **Extraordinary Inspection**
    - After flood hit
    - After earthquake occurred
  - **Comprehensive Inspection**
    - Every 30 years
- **Inspection by External Specialist** — **Periodic Inspection**
  - Every 3 years

Extraordinary inspection aftermath of great earthquake



The Check List and Inspection Manual

- For the Quick Response, the Check List is prepared for every state.
- Check lists are formulized for each specialized sector , Civil Engineering, Mechanical Engineering , Electrical Engineering

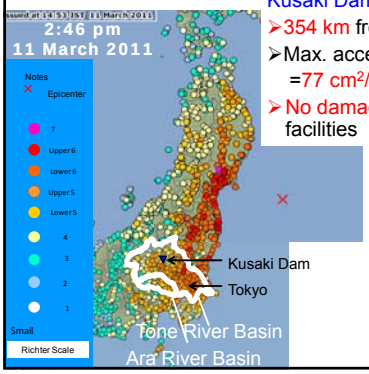
- Manual enables reliable check even in an emergency (e.g. earthquake), or by inexperienced person.

Safety Evaluation after Earthquake

The 2011 Great East Japan Earthquake: Mw=9.0

Kusaki Dam (JWA, Gravity, H=140m)

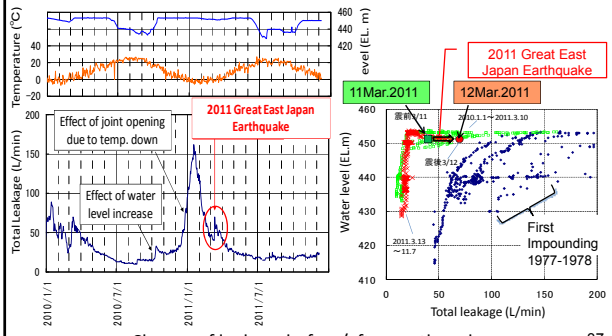
- 354 km from the epicenter
- Max. acceleration of dam base =77 cm²/s (upstream/downstream)
- No damage in the dam body and facilities



Safety Evaluation after Earthquake

The 2011 Great East Japan Earthquake: Mw=9.0

Kusaki Dam (JWA)



Change of leakage before/after earthquake

Management Policy on Electric, Information, Telecommunication and Mechanical Facilities for Dam O&M

Oct. 2016

Masahiro Sugiura, Ph.D.

Japan Water Agency

trust funded and administrated by

—Contents—

1. 1st Inspection for Post-earthquake on Electric, Information, Telecommunication and Mechanical Facilities

View Points for 1st inspection

Can we operate gates or not ?

To check
(1) gate condition
(2) gate operation equipments
(3) electric power supply
(4) communication tool
(5) water level of reservoir

Ichari Dam
Checklist for initial extraordinary inspection
Mechanical equipment

Implementation Date Time ～ Date Time

Name

Name of Equipment		Check Item	Procedure	State: Spillway Gate #1	#2	#3	#4	#5	#6	#7	FC gates #1	#2	#3	TCS #1	#2	Dewatering Gate #1	Auxiliary Gate #1	Intake Gate #1	#2	#3	#4	Reference
Gates	Opening and Closing Equipment, Wire rope	Leaning	Visual Check																			
		Leak of oil	Visual Check																			
	Local operation board	Leaning	Visual Check																			
		lighting position (normal / abnormal), Leaning	Visual Check																			
	Operation Board	Leaning	Visual Check																			
		Abnormality display	Visual Check																			
	Gate and gate stop	Crack or deformation	Visual Check																			
		Leakage	Visual Check																			
Inspection Boat			Visual Check																			
Elevator		Don't Use(Sign Board)																				
Drainage Pump	Local operation board	Leaning	Visual Check																			
	Drainage	Drainage Water from drain outlet	Visual Check																			

Remark

Ichari Dam
Checklist for initial extraordinary inspection
Electric and Telecommunication equipment

Inspectoin time & date
from : / / to : / /

E & TC	Check Items			Procedure	State (✓)		Remarks
Communication Equipment	Wireless communication equipment (ex. micro wave 8.5 GHz)		① call	Voice Check			
			② Measuring data check (Received signal level (dBm))	Visual Check			
	Mobile communication equipment (ex. VHF 150 MHz)		① call	Voice Check			
			② Measuring data check (Received signal level (dBm))	Visual Check			
	Cable communication		① call	Voice Check			
Electric power receiving and transforming equipment	Power supply (by electric company)		① Normal (measuring data check)	Visual Check			
	Emergency generator System	Emergency generator	①	Test Run/Visual Check			depend on test run time
		Fuel Tank	② Leaning, Broken, Leak of fuel on the floor	Visual Check			
Electrical equipment	Dam control system		① Normal (Check display panel)	Visual Check			
	Observational equipment (water level, rainfall etc.)		① Normal (Check display record)	Visual Check			
	Monitoring camera		① Normal (Check display panel)	Visual Check			
Others							

Before earthquake,

Operation and Maintenance for daily use
To keep best condition of water control facilities

After earthquake

Check of Condition by Check List
If it was broken, we repair it
and analysis why it was broken

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2. Concept of Facility Management

Basic Concept:

Safety and Reliability
in
Consideration of Economy

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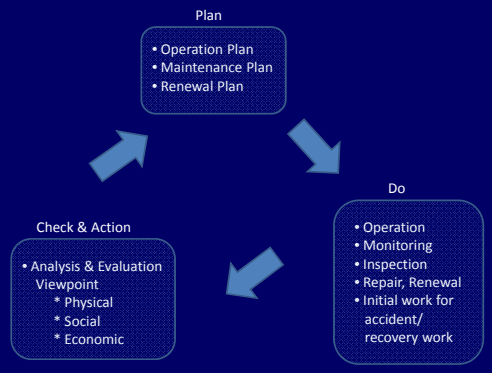
3. System of Facility Management and PDCA Cycle

PDCA Cycle



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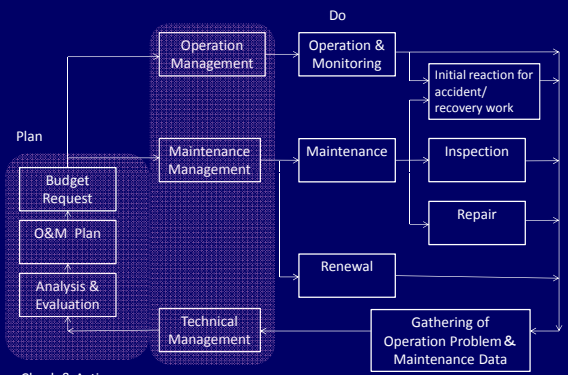
3. System of Facility Management and PDCA Cycle

System of Facility Management



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4. Facility Management Practices

Gathering of Operation Problem & Maintenance Data

Analysis & Evaluation Viewpoint
* Physical
* Social
* Economic

Engineering Capabilities

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4. Facility Management Practices

Gathering of Operation Problem & Maintenance Data

Purpose

Analysis & Evaluation
Developing O&M Plan
System Design

Operation Problem
* Operation record (switch, gate, alarm etc)
* Requested matters by Operator (good/bad operability etc)

Maintenance Data
* Results of inspection
* Repair record
* Comment by Maintenance Personnel

Basic Data
* Inventory book on Facility
Installation purpose, date and place, Specification, Repair record, Renewal plan
* Inventory book on Spare parts
Parts name, Model number, Manufacturer, Amount, Price, Storage place
* Failure history
Facility name and place, Date, Failure condition, Reason and repair

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4. Facility Management Practices

Check & Action

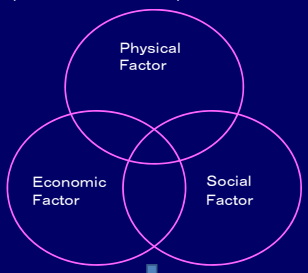
- Analysis & Evaluation Viewpoint
  - * Physical
  - * Social
  - * Economic

Physical Factor
- * Aging (deterioration)
- * Out of spare parts stock
- * Trouble of electric element

Social Factor
- * Technology obsolescence
- * Changing regulation
- * Social needs (noise, odor etc.)

Economic Factor
- * Operation cost
- * Maintenance cost
- * Asset value

Analysis & Evaluation on Facility Condition



Considering the points of Enhancement/Improvement

Considering the O&M Plan

13

4. Facility Management Practices

Engineering Capabilities

Purpose: Coordination for sustainable facility management

Operation management
- * Developing Manual for Daily operation and Initial reaction for accident
- * Technical guidance to successor

Maintenance management
- * Developing Manual for Maintenance and Initial reaction for recovery work
- * Technical guidance to successor

Technical Management
- * Analysis and Evaluation of result of inspection
  - Performance, Reliability, Maintainability, Life cycle cost, Technology selection, System design
- * Developing Plan
  - Review of O&M, Developing O&M plan

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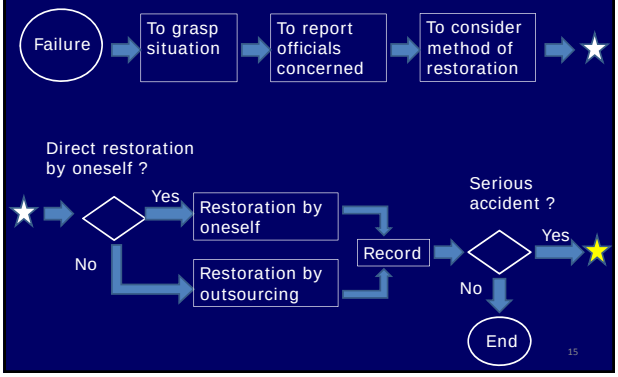
5. Failure Response



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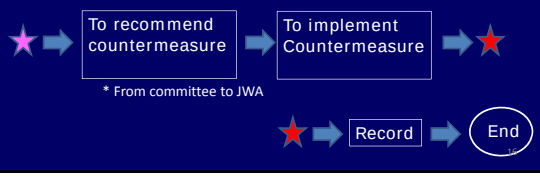
5. Failure Response
Accident investigation committee

* Professor of Univ., Manufacturer, JWA senior officer etc



* From committee to JWA

http://www.kendenkyo.or.jp/pdf/topics/kumamoto_fullreport.pdf

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Private Wireless Network of Japan Water Agency

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Precondition

* There are service technician for inspection.

* There are spare parts.

* There are budget for maintenance.

To choose and use domestic production.

* If you do not select domestic production……
To select a vendor with service technicians in India.

* If there are not budget for maintenance……
To have to think about income mechanism
for maintenance.
Cf. Electric generation, Beneficiary contribution
through local gov, etc.

19

Masahiro Sugiura, Ph.D.

1991-
* Ministry of Construction,
* Kinki Regional Construction Bureau
* Public Work Research Institute
* Water Resources Development Public Cooperation
* Japan Water Agency
* JICA Expert in Sabo Technical Center in Yogya (2001-2004)

Including
Design, construction and budget Management, O&M, Research on Water Resources Facilities

- Last 5 years –
2010 Commissioned Engineer,
Public Enterprise Bureau,
Saitama Prefectural Government
2012 Director for Water Control System,
Chiba Regional Water Control and Management Office,
Japan Water Agency
2015 Deputy Director,
Water Resources Engineering Department,
Japan Water Agency

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Practicing earthquake response drill at Ichari dam and lessons learned

20th October, 2016

Nobuyuki ICHIHARA

Japan Water Agency

trust funded and administrated by

Contents

The Disaster Preparedness Day in Japan

- In 1st September 1923,The great earthquake hit capital area of Japan. More than 100,000 people were killed or missing.
- Japanese gov. designated 1st September as “the disaster preparedness day ”to evoke memories of this tragedy.
- Since 1960, September 1st has been broadly recognized as the day to conduct earthquake response drill. On that day, most of Japanese join earthquake drill.

Recourse :Wikipedia

The view of the central of Tokyo after Large earthquake in 1st ,September1923

The objective of the field drill after the seismic event of JWA (Cont.)

- In order to maintain the system of the response after earthquake, every 1st September, JWA conducts the earthquake drill involving all dam operation and maintenance offices, branch offices and headquarter.

Photos of the field drill of JWA

Photos of the field drill of JWA-HQ in 2016

The objective of the field drill after the seismic event of JWA (Cont.)

- Not only JWA but also all organizations hold earthquake drills, from the Prime Minister, public services, private companies till kindergarten kids.

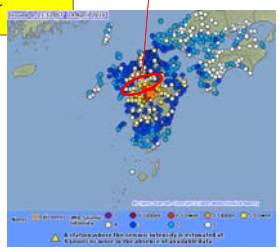
Photo: The field drill by railway company

Photo: The annual comprehensive disaster prevention drill for 2016
source: website of prime minister office

Example of the response for seismic event of JWA

Kumamoto Earthquake
14 April 2016
PM 9:26 JST
Mw 7.0
Max JMA Seismic Intensity 7

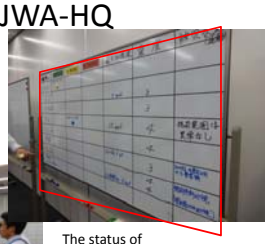
JWA dams, barrage and cannel are located in this area



Source: Wikipedia
10:50 16,April 2016

Emergency Operating Center of JWA-HQ

The officials in charge were mobilized
To Emergency Headquarter
Due to the information of Mobile phone

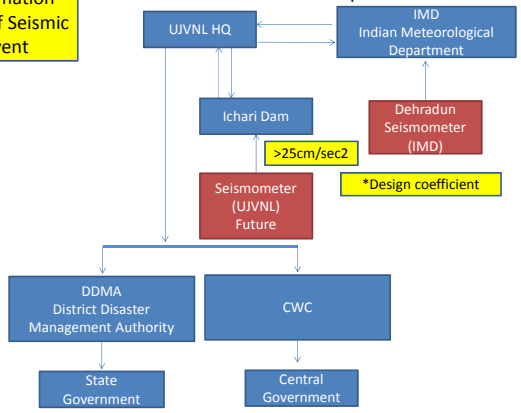


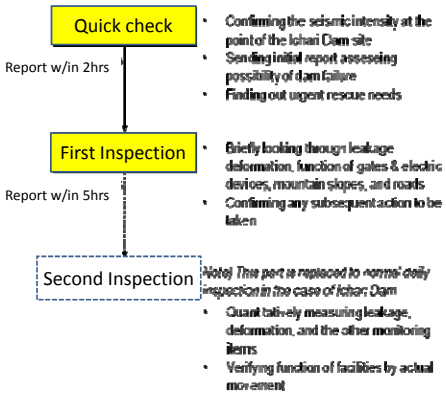
The status of JWA Faculties located Southern Japan

Photo Emergency Headquarter at PM10:30 14 April 2016 (an hour later of earthquake)

Information Flow of Seismic Event

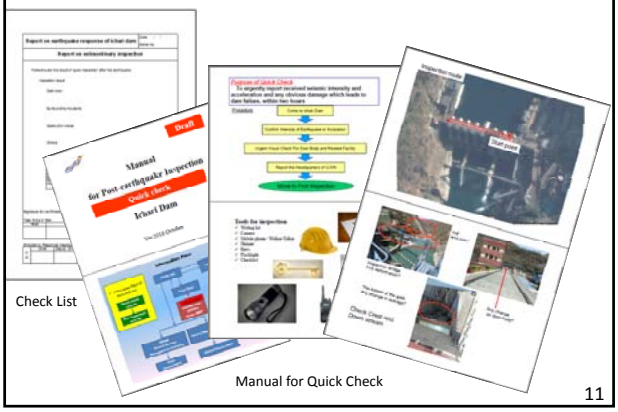
Outcome of Discussion 20 April





Framework of the emergency inspection of the Ichari Dam

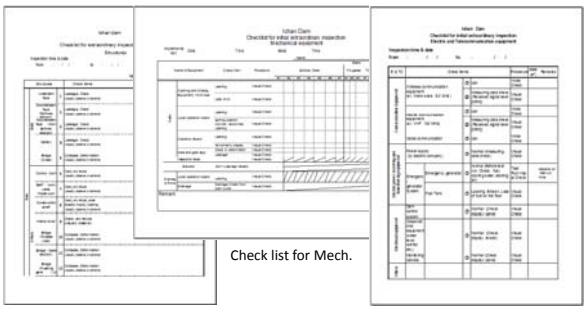
Check list & Manual for Quick Check



Check List

Manual for Quick Check

Check list for First Inspection

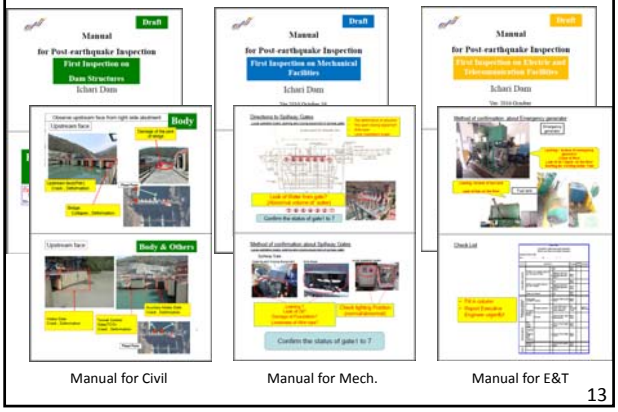


Check list for Civil

Check list for Mech.

Check list for E&T

Manuals for First Inspection



Manual for Civil | Manual for Mech. | Manual for E&T

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The objective of the drill at Ichari Dam

- Through the experience of field drill, field engineers are expected to enhance their capacity on response after earthquake.
- To update manuals through inspection of the facilities.

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Preparation of the scenario

- The objective of the preparation of scenario is
  - To clarify responsibility and action to be taken by related officials after earthquake
  - To identify any difficulties in the response of earthquake in advance.

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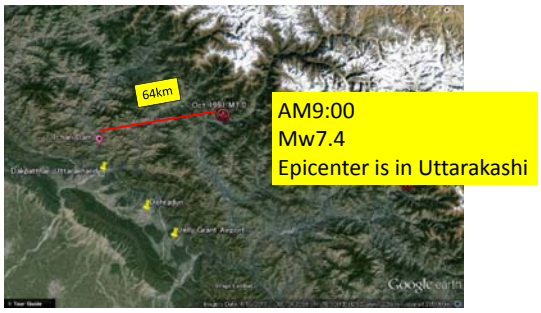
The scenario earthquake for the field drill in Ichari dam on 18th Oct.



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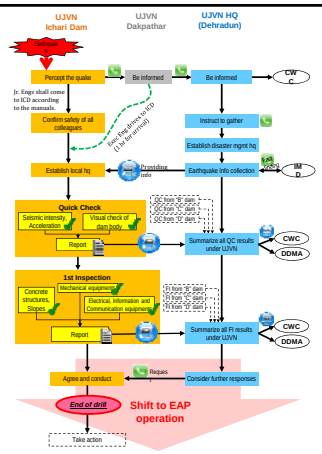

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Details of Scenario

When | Action | From who | To whom

Speak

Time	Events and actions	From who	To whom	Discussion point
9:00	M7.4, epicenter at Uttarkashi (63km from Ichari)			
9:05	Jr. Eng. at ICD reports to Exec. Eng. at DPT that he felt a strong quake now. *"This is a drill. I felt a strong quake just now. Currently, ## staff members are on duty, but their safeties have not yet been confirmed."* All Jr. Eng. need to come to the ICD after confirming their family. Then, Jr. Eng will confirm safety of all his colleagues.	UJVN-ICD Post: Jr. Eng. Name: (on duty at that time)	UJVN-DPT Post: Exec Eng. Name: Muhammad Nasiqui	
9:10	Exec Eng reports to UJVN headquarters *"This is a drill. It was reported that there had been a significant quake at ICD. I also felt at DPT. I am departing for ICD now and will arrive one hour later."*	UJVN-DPT Post: Exec Eng. Name: Muhammad	UJVN-HQ Post: Exec Eng. Name: Rajib Kumar	
9:15	Exec Eng call to Asst Eng: *"This is a drill. It was reported that there had been a significant quake at ICD. I am departing for ICD with you. (then, confirm meeting point and timing)"*	UJVN-DPT Post: Exec Eng. Name: Muhammad	UJVN-DPT Post: Asst Eng. Name: Bhanu Joshi	
9:15	The recipient calls all members for emergency response to the headquarters. *"This is a drill. There seemed to be a significant earthquake at north ... the headquarters immediately."*	UJVN-HQ Post: Exec Eng.	UJVN-HQ Post: Deputy GM	This time, only two persons will undertake a duty of disaster mgmt at UJVN-HQ.

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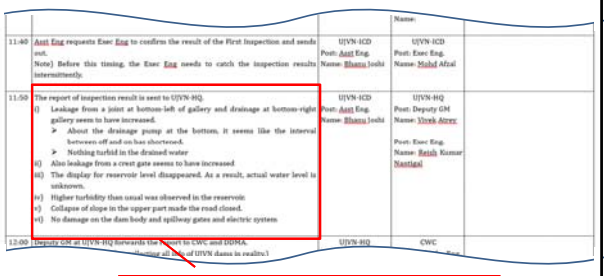
Details of Scenario(Cont.)



11:40	Asst Eng requests Exec Eng to confirm the result of the First Inspection and sends out. Note) Before this timing, the Exec Eng needs to catch the inspection results intermittently.	UJVN-ICD Post: Asst Eng. Name: Bhanu Joshi	UJVN-ICD Post: Exec Eng. Name: Mohd Afzal
11:50	The report of inspection result is sent to UJVN-HQ. i) Leakage from a joint at bottom-left of gallery and drainage at bottom-right gallery seem to have increased. ➢ About the drainage pump at the bottom, it seems like the interval between off and on has shortened. ➢ Nothing turbid in the drained water ii) Also leakage from a crest gate seems to have increased iii) The display for reservoir level disappeared. As a result, actual water level is unknown. iv) Higher turbidity than usual was observed in the reservoir. v) Collapse of slope in the upper part made the road closed. vi) No damage on the dam body and spillway gates and electric system	UJVN-ICD Post: Asst Eng. Name: Bhanu Joshi	UJVN-HQ Post: Deputy GM Name: Vivek Arrey Post: Exec Eng. Name: Rajib Kumar Nautiyal
12:00	Deputy GM at UJVN-HQ forwards the Report to CWC and DDMA.	UJVN-HQ	CWC

The scenario can flexibly assume damages and troubles concerning earthquake in order to enhance the capacity of field engineers

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Scenario	Actual
09:05	09:05

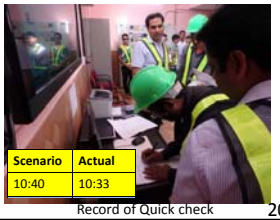
Report from Jr. Eng. To Exec Eng.

Scenario	Actual
10:20	10:13

Arrival and instruction of Exec Eng.

Scenario	Actual
10:20	10:13

Quick check start



Scenario	Actual
10:40	10:33

Record of Quick check

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Scenario	Actual
10:40	10:33

Report to UJVNL-HO

Receipt of report at UJVNL-HO

Scenario	Actual
10:50	10:37

First Inspection of Civil group

First Inspection of Mech. group

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Scenario	Actual
11:40 (finish)	11:40

First Inspection of E&T group

Scenario	Actual
11:50	12:18

Report to UJVNL-HO

Briefing for DRIP members

Short meeting for feedback of the drill

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Feedbacks from drill players

- From UJVNL-HQ
  - The report sending to CWC should be summarized by HQ from respective reports. The form for this is required in advance.
  - It is required to make another rule in case of quake perception at Dakpathar even if no notification from Ichari Dam.
  - It needs to be considered how to share information and emergency tasks within HQ officials.
  - Due to restriction of satellite internet capacity, it would be better dividing into a couple of messages or scanning in lower resolution. Broadening the internet capacity is also good, if possible. (This issue was also raised from Ichari Dam)
  - For appropriate work sharing and technical support to the field engineers, HQ expert team should be organized from initial phase.

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Feedbacks from drill players (Cont.)

- From Ichari Dam
  - For confirming the safety of officials and their families, Exec Engineer should contact Jr. Engineers in Kotti colony after receiving information of earthquake from Ichari dam.
  - Taking into account preparation time, it needs 1.5 hour to arrive at Ichari Dam from Dakpathar after receiving the notification.
  - The Quick Check does not require expertise, so it should be urgently implemented by Jr. Engineer before arrival of Exec Eng.
  - In order to shorten first inspection time, the number of officials in each inspection group should be reviewed according to quantity of work.
  - The operation of Ichari dam is directly linked with the operation of Chibro Power St., so the officials of Chibro Power St. should be involved in the future drill.

END

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Recommendations from JWA's Experiences

Tatsuo KUNIEDA

Japan Water Agency

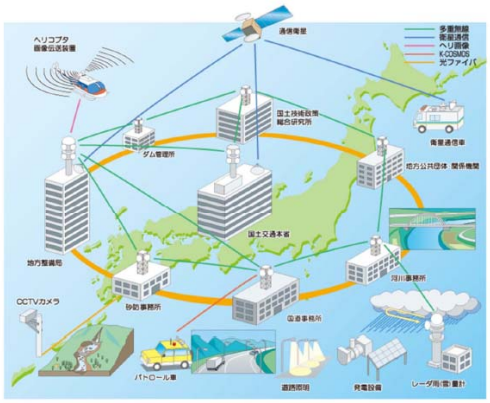
trust funded and administrated by THE WORLD BANK

Securing communication lines

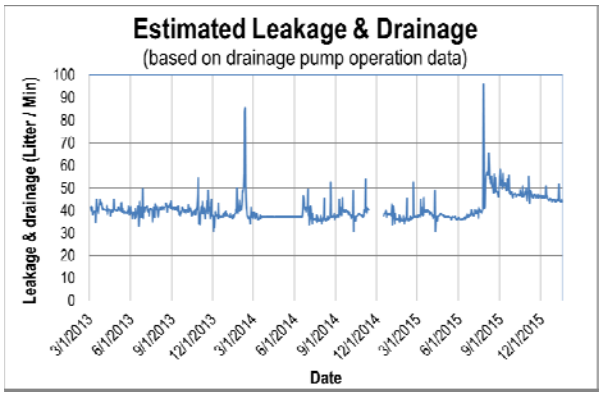
Exclusive communication line

- ✓ Satellite
- ✓ Wireless wave
- ✓ Optical fiber cable

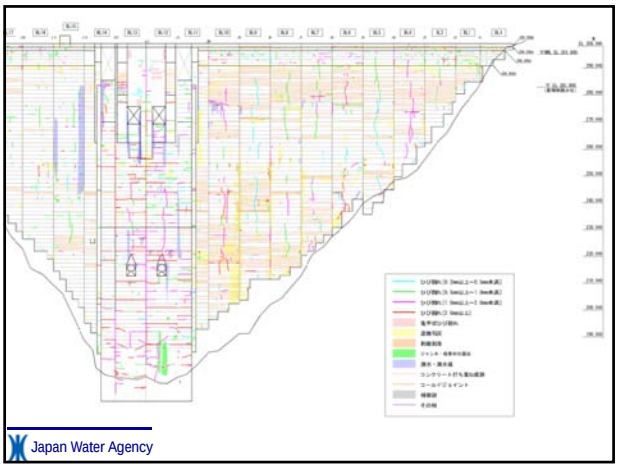
Priority commercial line



Monitoring leakage and drainage



Recording Cracks



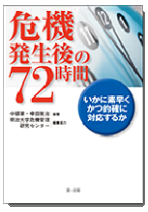
Japan Water Agency

Japan Water Agency

Fuel in emergency power generator

72 hrs

Japan Water Agency



Japan Water Agency

Thank you.

Water supports wealthy society
Incorporated Administrative Agency
JAPAN WATER AGENCY (JWA)

Central Dam Safety Organization

Central Water Commission

Vision

To remain as a premier organization with best technical and managerial expertise for providing advisory services on matters relating to dam safety.

Mission

To provide expert services to State Dam Safety Organizations, dam owners, dam operating agencies and others concerned for ensuring safe functioning of dams with a view to protect human life, property and the environment.

Values

Integrity: Act with integrity and honesty in all our actions and practices.

Commitment: Ensure good working conditions for employees and encourage professional excellence.

Transparency: Ensure clear, accurate and complete information in communications with stakeholders and take all decisions openly based on reliable information.

Quality of service: Provide state-of-the-art technical and managerial services within agreed time frame.

Quality Policy

We provide technical and managerial assistance to dam owners and State Dam Safety Organizations for proper surveillance, inspection, operation and maintenance of all dams and appurtenant works in India to ensure safe functioning of dams and protecting human life, property and the environment.

We develop and nurture competent manpower and equip ourselves with state of the art technical infrastructure to provide expert services to all stakeholders.

We continually improve our systems, processes and services to ensure satis-

DRIP
Dam Rehabilitation & Improvement Project