THE INTERNATIONAL ENERGY AGENCY TECHNOLOGY COLLABORATION PROGRAMME ON HYDROPOWER

IEA Hydropower

Presentation

Annex-XV

Current Approaches on Asset Management in USA, Canada, Japan

アメリカ、カナダ、日本におけるアセットマネジメントに対する現在の取組み

and

Case Histories for “Decision-making for Maintenance Works and Upgrading of Hydro Facilities”

水力発電設備の保守業務と増強に関する意思決定」事例収集結果

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Annex-XV OA 執行責任者

J-POWER, Shingo TAKAGI 髙木慎悟

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(1) General Information
(2) Decision-making Drivers
(3) Overall Asset Management (AM) Process
(4) Information on AM Processes
(5) Information on AM processes at Asset Level
(6) Information on AM Component and Strategy

(1) General Information

- Surveyed company
  - ✓Total : 25 Nos.
    - ・Public-state or Municipal : 19 Nos.
    - ・Private-listed : 6 Nos.

- Overall Capacity
  - ・Public-state or Municipal : 11～ 355 MW
  - ・Private-listed : 2,446～9,871 MW

- Number of Hydro Plants
  - ・Public-state or Municipal : 1～ 32 plants
  - ・Private-listed : 61～209 plants
- Number of Hydro Units
  - ・Public-state or Municipal : 1～ 37 units
  - ・Private-listed : 111～311 units

- Average age
  - ・Public-state or Municipal : 33～62 years
  - ・Private-listed : 44～77 years

- Age Range
  - ・Public-state or Municipal : 52～ 93 years
  - ・Private-listed : 64～127 years

✓The oldest hydropower plant has been in operation for 127 years.

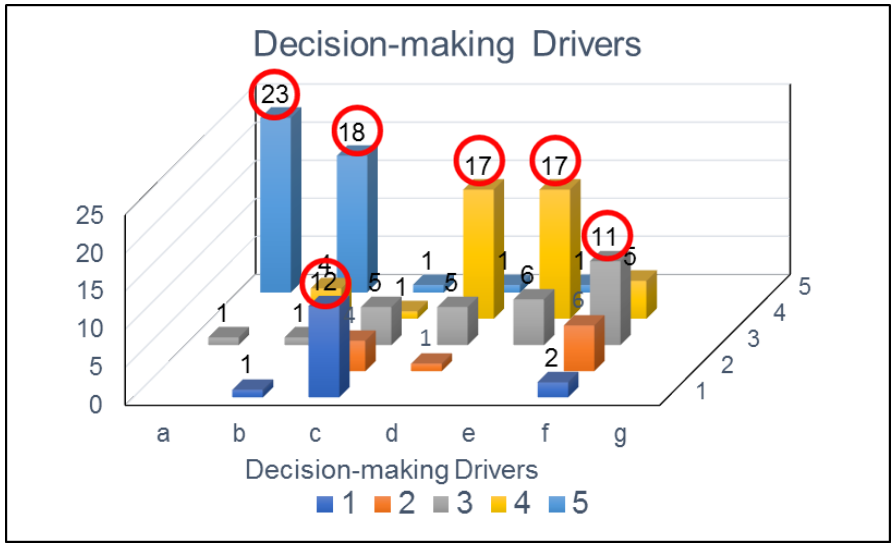
✓Each company owns at least one plant with more than 52 years old.

(2) Decision-making Drivers

(Number of responses)

Decision-making Drivers		Rating				
		1	2	3	4	5
Meet Regulatory Requirements/Compliance	a			1		23
Ensure Safety, Manage Social and Environmental Issues	b	1		1	4	18
Meet Electricity Market Requirements	c	12	4	5	1	1
Manage Asset Risk	d		1	5	17	1
Maintain Asset Value (including production levels)	e			6	17	1
Increase Asset Value	f	2	6	11	5	
Other	g					

Description;
Rating: Level of Importance
1 Not considered under normal circumstances
2 Modest, of limited importance overall or only considered for a few hydro plants
3 Generally important, or highly important for a few hydro plants
4 Highly important across the portfolio (of hydro plants), drives major decisions
5 Fundamental across the portfolio (of hydro plants), decisions must address this issue



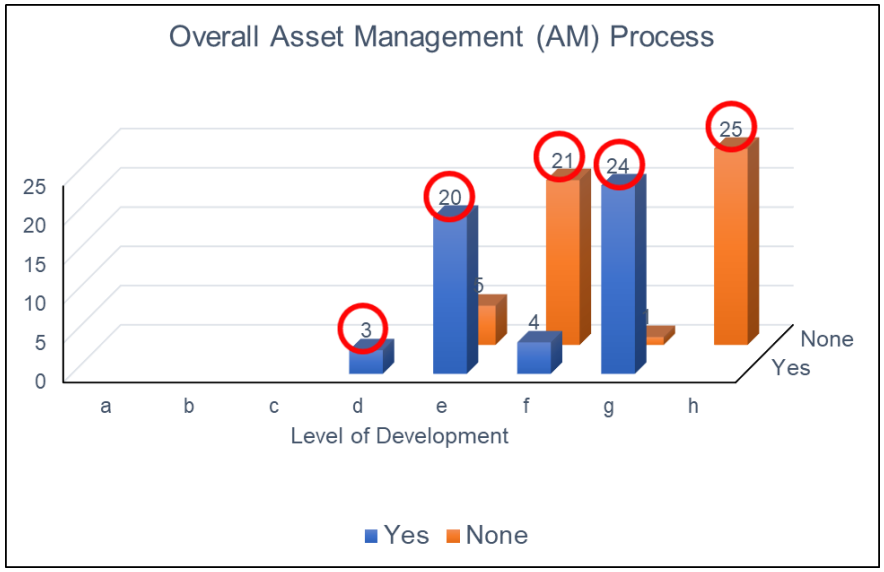
- **Meet Regulatory Requirements / Compliance (a)**
  - ✓ These are considered as "fundamental across the portfolio, decision must address this issue" by most of the companies.
- **Ensure Safety, Manage Social and Environmental Issues (b)**
  - ✓ The level of importance is considered to be the highest by many companies.
- **Meet Electricity Market Requirements (c)**
  - ✓ Meet Electricity Market Requirements are not considered under normal circumstances by 50% of the companies.
- **Manage Asset Risk (d) and Maintain Asset Value (e)**
  - ✓ These are considered as "highly important across the portfolio, drivers major decisions" by many companies.
- **Increase Asset Value (f)**
  - ✓ It is considered as "generally important, or highly important for a few hydro plants" by many companies.

(3) Overall Asset Management (AM) Process

(Number of responses)

Level of Development		Check: Yes	Check: None
No AM process in place	a		
Considering development of a AM Process	b		
Committed, AM process designed, but not yet implemented	c		
AM Process partially Implemented	d	3	
AM Process fully implemented	e	20	5
AM Process fully implemented, with external review	f	4	21
Annual Strategic Asset Plan	g	24	1
ISO Registered (or similar)	h		25

Description;
- a -
- b Reviewing and understanding the AM process
- c Decision made to embrace AM process, with design to meet company requirements
- d Some components completed
- e Processes in place and followed
- f AM Process reviewed by audit or formal process
- g -
- h -



➢**AM Process (a)～(f)**
- ✓ AM process is implemented partially or fully by most of the companies.
- ✓ AM process is implemented based on the safety regulations etc. under Article 42 of the Electricity Business Act.

➢**Annual Strategic Asset Plan (g)**
- ✓ Some strategic asset plans are prepared by many companies, e.g.
  - • Medium to long term maintenance plan for 5-15 years.
  - • Annual maintenance plan (1 year)
  - • Profit plan (1 year) , etc.

➢**ISO Registered (h)**
- ✓ No company has registered AM process as ISO.

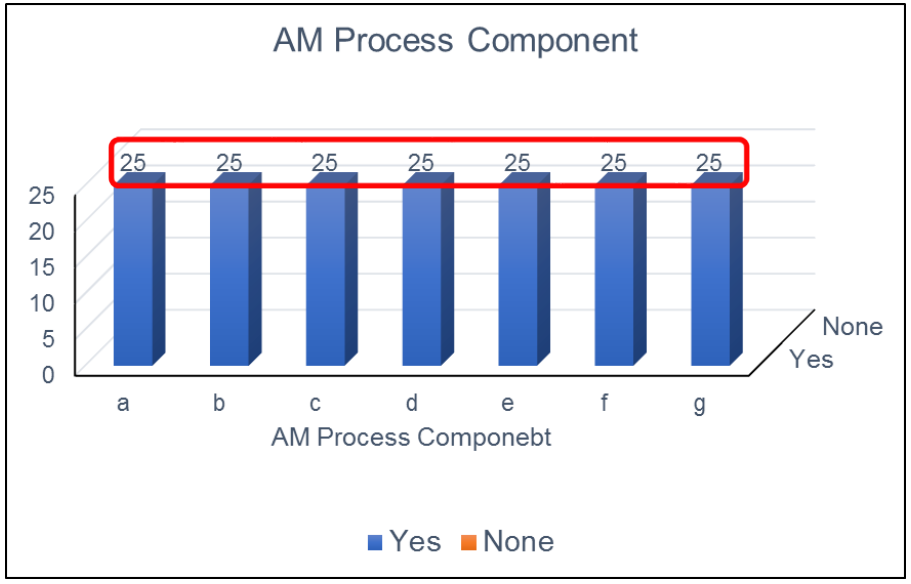
(4) Information on AM processes

(Number of responses)

AM Process Component		Check	
		Yes	None
Issues	a	25	
Risks	b	25	
Issue and risk assesment	c	25	
Prioritization	d	25	
Treatment	e	25	
Approvals	f	25	
Implementation	g	25	

Description;

a Is there a formal process to identify equipment or system issues?
b Is there a formal process to identify equipment or system risks?
c Is there a formal process to assess issues and risks?
d Is there a formal process to prioritize issues and risks?
e Is there a formal process to determine appropriate levels of equipment or system treatment?
f Is there a formal process to obtain approvals for selected treatments in terms of costs and timing?
g Is there a formal process to deliver projects?



➢ **AM Process Component (a)～(g)**

✓ All of components are considered in their AM Process by most of the companies.

✓ Condition Based Maintenance (CBM), Risk Based Maintenance (RBM) or Time Based Maintenance (TBM) is introduced by several companies. Usage situation is as follows:

Usage situation of CBM, RBM or TBM

(Number of responses)

	Equipment	Assesment c	Prioritization d	Treatment e
CBM	for Civil for Electro-mechanical	2	1	1
RBM	for Civil	2	2	1
TBM	for Electro-mechanical	1		1

CBM: Condition Based Maintenance
RBM: Risk Based Maintenance
TBM: Time Based Maintenance

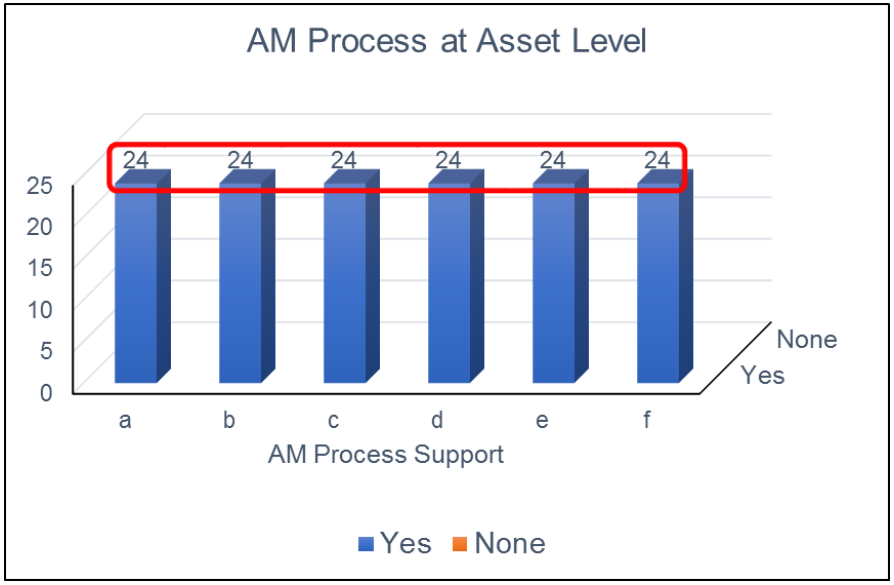
(5) Information on AM processes at Asset Level

(Number of responses)

AM Process Support		Check	
		Yes	None
Asset Plans at Hydro plant Level	a	24	
Asset Type Plan	b	24	
Technical support (trouble shooting and diagnostics)	c	24	
Engineering design	d	24	
Project Management	e	24	
Implementation support for major works	f	24	

Description;

- a Prepare Asset Plans to capture and summarize all relevant asset condition, performance and risk information?
- b Prepare Asset Type Plans to summarize information on specific equipment or system type across portfolio?
- c Provided mainly by in-house or external resources?
- d Provided mainly by in-house or external resources?
- e Provided mainly by in-house or external resources?
- f Provided mainly by in-house or external resources (excluding OEMs)?



- **Asset Plans at Hydro plant level (a)**
  - ✓ Investigation plan for each hydro plant is prepared based on the internal regulation about investigation details of each equipment by most of the companies.
- **Asset Type Plan (b)**
  - ✓ Investigation details of each equipment are stipulated in the internal regulations by most of the companies.
- **Technical support, Engineering design, Project Management and Implementation support for major works (c～f)**
  - ✓ These are provided by in-house resource or associated companies. But, some cases are provided from external resources.

(6) Information on AM Component and Strategy

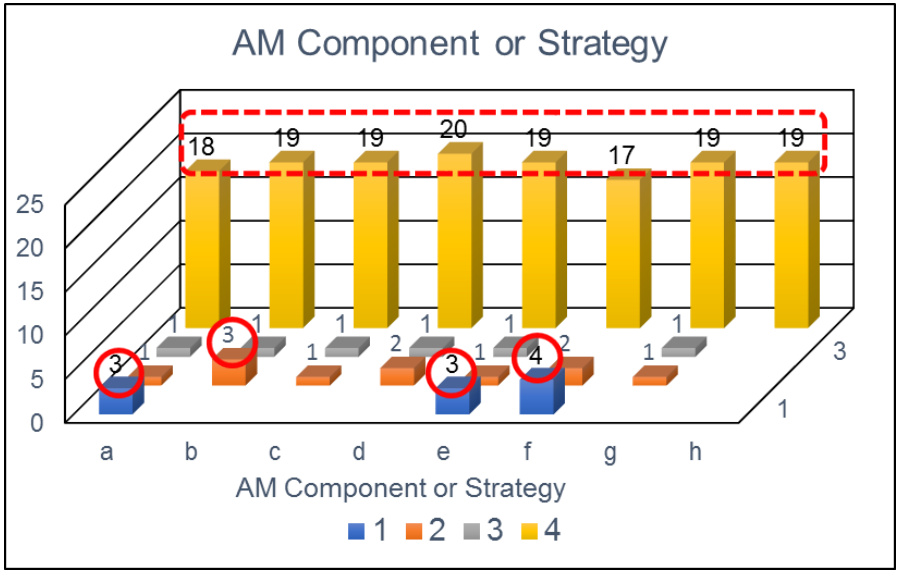
(Number of responses)

AM Component or Strategy		Check 1	2	3	4
Portfolio AM System (e.g.C55)	a	3	1	1	18
Condition Assessment Software (e.g.HydroAmp)	b		3	1	19
Performance Software	c		1	1	19
Use of Key Performance Indicators (KPI)	d		2	1	20
Plant Intelligence or diagnostics system	e	3	1	1	19
Maintenance Management System (e.g.SAP, Maximo)	f	4	2		17
Risk Assessment Software or System	g		1	1	19
Others	h				19

Description;

1. Fully Incorporated and Operated.
2. Partly Incorporated or Under Development.
3. Under Consideration.
4. Decided Against.

Greatly affected by the answer from public-state or municipal company



- **AM Component or Strategy (a)～(h)**
  - ✓ Commercially supplied software or system has not been incorporated. Many companies have various in-house software and system.
  - ✓ Almost all companies have the following in-house system:
    - ・Fixed asset ledger (asset information such as acquisition and retirement of assets)
    - ・Facility control ledger (construction / work history information for each facility / equipment)
    - ・Construction history register (contract date, construction period, contractor, overview, etc.)
  - ✓ In most of the companies, “Risk Assessment Software or System” has not been incorporated.

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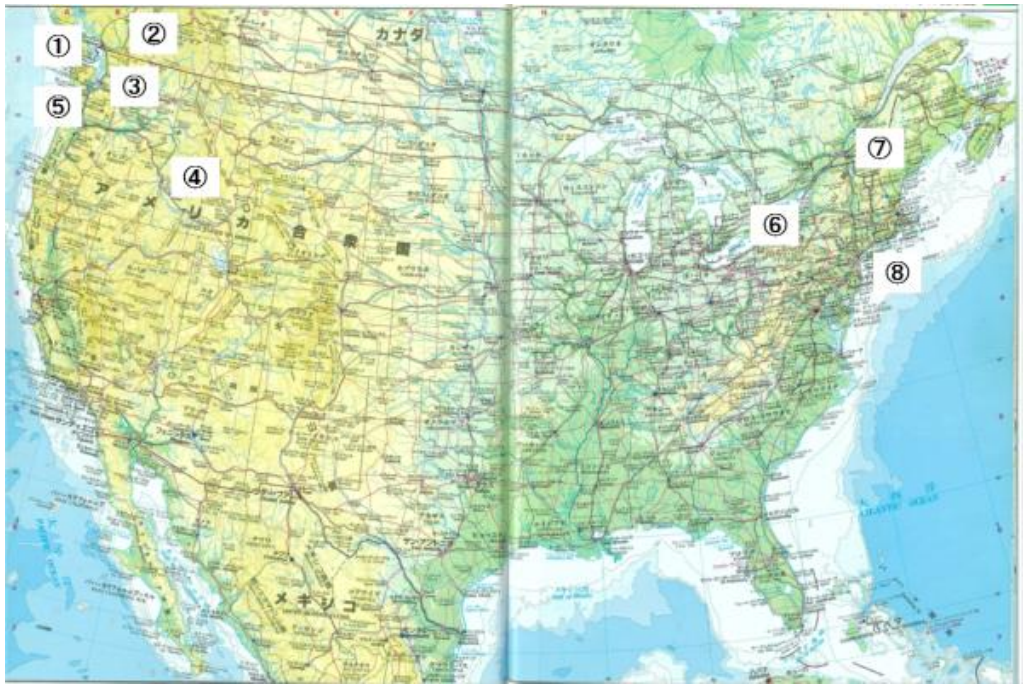
1.2 Results of Site Visit in USA and Canada

(1) General Information
(2) Outline of each Utility
(3) Feature of Hydropower Utilities in USA and Canada
(4) Findings of Approaches for Asset Management

(1) General Information

- Period: Jul.29.2018～Aug.12.2018
- Countries: USA & CA
- Visited Utilities:
  ①Copper Leaf Co., ②Fortis BC, ③Snohomish Country PUD, ④Reclamation Office Idaho, ⑤Tacoma Power, ⑥Ontario Power Gen., ⑦CEATI, ⑧NY Power Authority



Location of Visited Place

- Hearing issues

- Term of AM Introduction
- Maintenance Manual
- Data Collecting of Structures & Electric-Mechanical Equipment
- How to find Problem
- Phenomena for Decision-making
- How to analyze problem and Phenomena
- Risk management
- Decision-making method

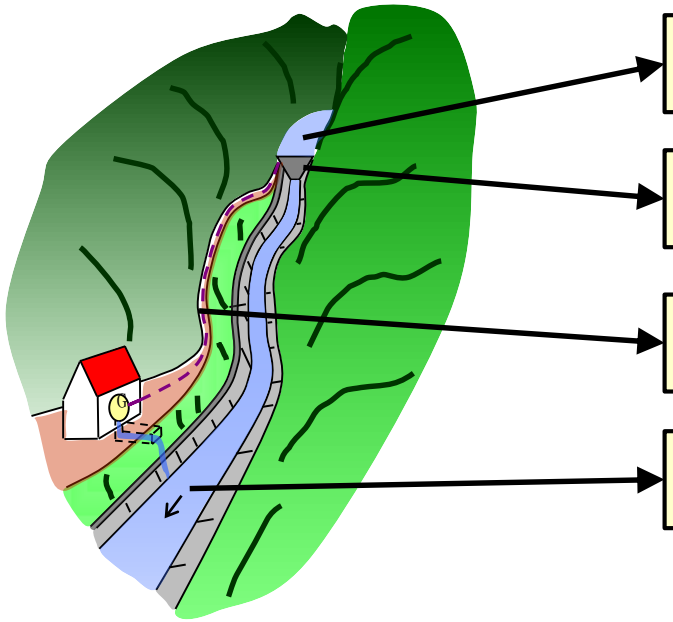
(2) Outline of each Utility

Item	Fortis BC	Tacoma Power	Snohomish Country PUD	US Bureau of Reclamation Idaho	New York Power Authority	Ontario Power Generation
Classification	Private Co.	City Public Utility	City Public Utility	USA Government	State Public Utility	State Public Utility
History	Established in 1897 Acquired in 2003	City acquired light & water company in1893	Established in 1936 Operation started in 1949	Decided to establish by Congress in 1902	Signed by President in 1931	Established in 1999
Customer	111,500+48,500	175,870	350,000			
Supplying Area	Canada Middle South of British Columbia State	USA Tacoma, University Place, Fircrest, Fife in Washington State	USA Snohomish, Camano Island in Washington State	USA	USA New York State	Canada Ontario State
Line	about 7,200 km				2,400km (Trans.)	
Hydro Asset	The Kootenay Riv. (4 Stations) 223MW Walden North 16MW Others 599MW Total 838 MW	MOSSYROCK DAM 300MW MAYFIELD DAM 162MW ALDER DAM 50MW LAGRANDE DAM 64MW WYNOOCHEE RIVER PROJECT 10.8MW Total 586.8 MW	Jackson 48MW Calligan Creek 6MW Hancock Creek 6MW Woods Creek 0.65MW Youngs Creek 7.5MW Packwood 2MW Total 70MW (7% of electricity supply)	Pacific North West 10 Stations Total 7,463 MW Including Grand Coulee P/S 6,735 MW Columbia River 31 Stations	Niagara 2,441 MW ST. Lawewnce 800MW Belenheim PSP 1,160 MW Small Hydro 10MW Total 4,411 MW	Sir Adam Beck 1,997MW Des Joachims Generating Station 429MW Sir Adam Beck Pump GS 174MW Otto Holden Generating Station 243MW 65 Stations Total 7,438MW
Asset except Hydro	-				LNG 1,096 MW	Nuclear 6,606MW Thermal 2,458MW Biomass 205MW Wind 7MW Total 9,826 MW
Raised Electricity			Bonneville Power Administration 81%			
Supply			About 1,000MW		5,507MW	17,264MW

(3) Feature of Hydropower Utilities in USA and Canada

- There are a variety of hydropower utilities whose number of hydropower assets varies from a few to so many with not only hydropower assets but also thermal power and nuclear assets, which means there are some differences for engagement with asset management between the utilities.
- In Canada, regulation for hydropower plants is different by each state.
- Authorities' regulation role sharing for Hydropower structures in USA is shown in the figure below.

Authorities' sharing roles for regulation of Hydropower structures in USA



Reservoir and its surroundings are regulated by US Bureau of Reclamation.

Technical issue of dam is regulated by US Army Corp. General issue is regulated by US Bureau of Reclamation

Water way structures and Power house structure is regulated by FERC. ※ Federal Energy Regulatory Commission

River is regulated by US Bureau of Reclamation.
River issues concerned with hydropower is regulated by FERC.

(4) Findings of Approaches for Asset Management

a. General

- Approaches for AM
  - Private Utility is nervous for regulation authority's instructions, and has higher consciousness for AM than public utility. (Fortis BC)
  - The larger scale of owned assets, the stronger its AM system is. (USBR, NYPA, OPG)
  - AM is mainly aimed for electric-mechanical equipment. Data measurement management is not so important for civil structures (especially, dams).
- AM for structures by utility
  - Authorities' regulation role sharing for Hydropower structures in USA is as the previous page.
  - Some utilities are entrusted for dam operation and maintenance.

b. Practice

- OM manual preparation
  - CEATI and OEM are referred at manual preparation stage. (Fortis BC)

    CEATI: The Centre for Energy Advancement through Technological Innovation

    OEM: Original Equipment Manufacturer
  - Measurement of structure is compliant to regulation authority manual. (FERC)
- Data measurement
  - The present newest style of data collection is based on IOT. (NYPA)
- Findings for Practice on OM
  - Abnormal data detection is mainly based on data measurement and check list.
  - For check list storage, tablets are utilized for data input on software such as MAPCON and EXCEL.
  - Utilization of Packaged Software
    - SAP and IBM MAXIMO are utilized for measured data collection.
    - Value Based management is adopted for some software as a method of AM.
    - SATN is utilized to make Assess Tree.
    - C55 is utilized for decision-making by portfolio optimization based NPV method.
- Decision-making and AM
  - Utility whose AM system is almost completed recognizes that the new hydropower development era has been already finished, and they put importance on AM. (US Bureau of Reclamation Idaho, New York Power Authority）

1.3 Summary

Japan

- The following matters are regarded as important as decision-making factors.:
  ・Meet Regulatory Requirements / Compliance
  ・Ensure Safety, Manage Social and Environmental Issues
- AM process is implemented partially or fully by most of the companies.
- Some strategic asset plans are incorporated.
  e.g. Medium to long term maintenance plan for 5-15 years
  Annual maintenance plan (1 year)
  Profit plan (1 year))
- Compliance with regulations is the basis of quality management.
- All of components (issues, risks, issue and risk management, prioritization, treatment, approvals, implementation) are considered in AM Process.
- Condition Based Maintenance (CBM), Risk Based Maintenance (RBM), Time Based Maintenance (TBM) are introduced.
- Technical support, Engineering design, Project Management and Implementation support are basically provided by in-house resource or associated companies.
- In-house software and system are used.

USA and Canada

- Relation between owned asset and AM practice contents is as follows:

AM Practice Contents	Owned assets scale		
	small	medium	large
OM manual	○	○	○
Check list	○	○	○
Data measurement	○	○	○
Engineering Center		○	○
Data storage center			○

- OM manual, Check list, and Data measurement are essential in AM.
- The larger owned assets scale becomes, the higher the needs to study cause of abnormal value of data technically becomes. Therefore, organization such as Engineering Center is required.
- If the scale of owned assets becomes more larger, it is necessary to process big data. Therefore organization such as Data Storage Center to collect big data unitarily in one place is required.
- In many utilities, decision-making is executed in AM division.

2. Case Histories for “Decision-making for Maintenance Works and Upgrading of Hydro Facilities”

2.1 Case Histories in Japan

(1) Asset Management Methodology in Japan

(2) Collection and Analysis of Case Histories

(3) Environment surrounding Maintenance Works of Hydro Facilities in Japan

(4) Trigger, Decision Making and Risk Management

(1) Asset Management Methodology in Japan

Daily Operation & Maintenance

- Periodical Inspection
  - Visually
  - Measurement
- Periodical Maintenance

- Deformation
- Abnormal Value

Trigger Phenomenon

- Aging Deterioration
  (Renewal & Upgrading of T/G, Improvement of Civil Facilities, Abolition)
- Disaster Recovery
  (Flood& Heavy Rain, Earthquake, Public Safety)
- Social Demand
  (Environment, Sedimentation, Flood Control, Demand from Local Community)
- Efficiency Improvement & Operation Review
  (Increase Revenue, Labor Saving of Management, Operational Change)
- Effective Utilization of Water Resources
  (River Maintenance Flow Facilities, Existing Hydropower Facilities, Others)

Risk

- Income Decrease, Repair & Maintenance Cost Increase, etc.
- Local community's Antipathy, Harmful Rumor, etc.
- Social Responsibility, Compensation, Influence on Stock Price, etc.

- Risk Management
  - Acceptance
  - Transfer
  - Decrease
  - Avoidance

Countermeasures

- Cost
- Benefit

Decision-making

- Maintenance & Repair
- Renewal & Upgrading
- Refurbishment
- Expansion
- Redevelopment
- Abolition

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(2) Collection and Analysis of Case Histories

a. Data Collection

- 193 case histories in Japan are extracted in total.

b. Decision-making and its content

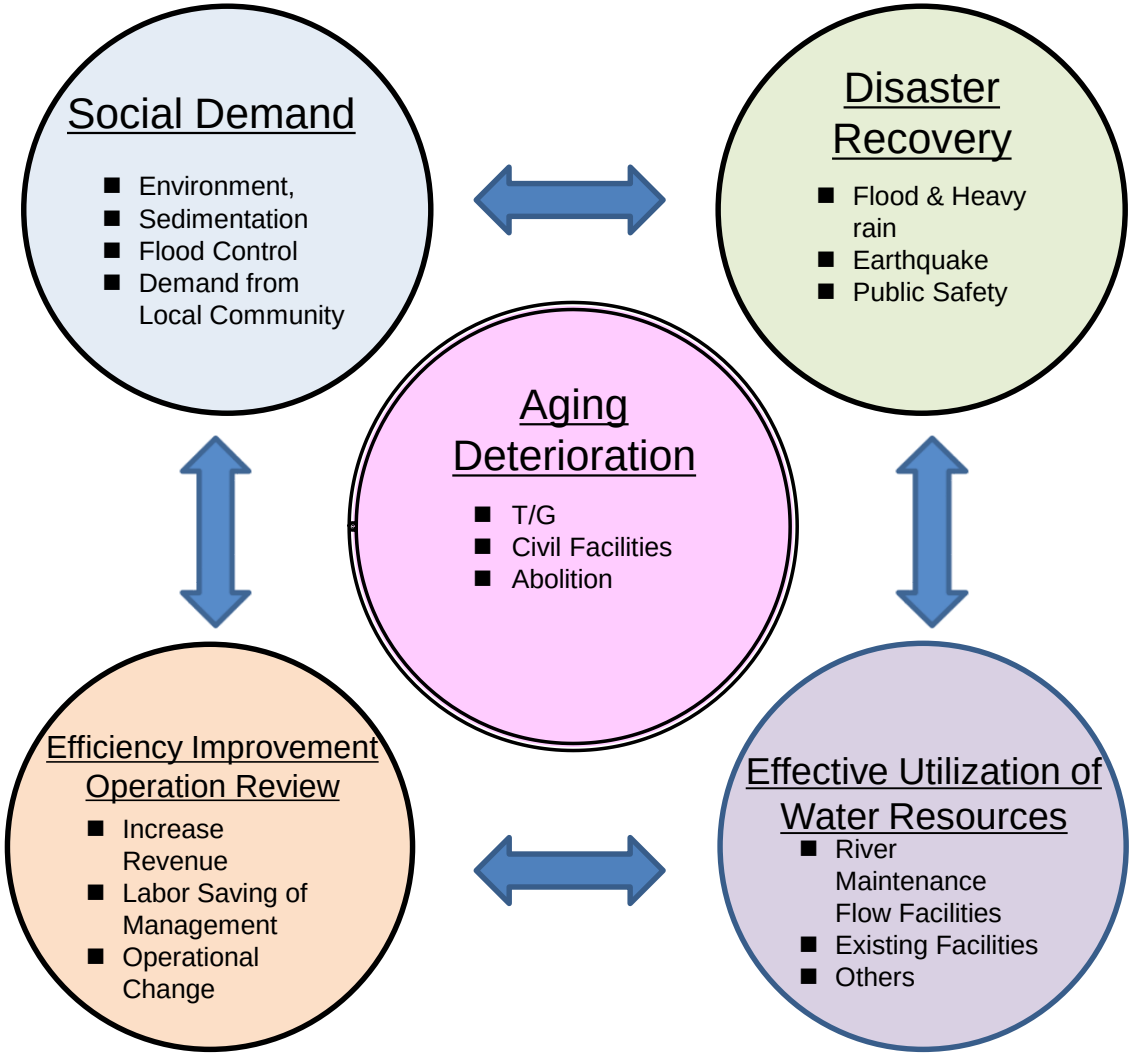
Options	Contents
Maintenance & Repair	“Maintenance & Repair” of main structures and facilities of a power plant or its ancillary facilities.
Renewal & Upgrading	“Renewal & Upgrading” of main structures and facilities of a power plant or its ancillary facilities.
Refurbishment	“Refurbishment” of main structures and facilities of a power plant or its ancillary facilities required from a change of surrounding social and natural environment.
Expansion	“Expansion” of main structures and facilities of a power plant for a power business opportunity created from a change of situation of power demand & supply or power policy.
Redevelopment	“Redevelopment” of a power plant with large-scale construction works due to a development of another project or disaster.
Abolition	“Abolition” of a power plant.

（Note） Main Structures : Dam, Intake, Headrace, Tank, Pressure Tunnel, Powerhouse, Foundation of Machines, Tailrace, Outlet
Facilities : Electrical Equipment（Turbine, Generator）, Mechanical Equipment（In-house Crane, Gate, Screen, Penstock）
Ancillary Facility :The Others

c. Risk Management and its content

Options		Contents
Yes	Avoidance	Includes not acting on risk itself, or withdrawing from a risky state.
	Decrease	Includes reducing the probability of occurrence of risk or magnitude of influence or both
	Transfer	Various insurance, etc.
	Acceptance	Active retention (reserves, funding, etc.), passive retention (not taking any action after recognizaing it, unrecognizable, etc.)
No		Other than risk management

(3) Environment surrounding Maintenance Works of Hydro Facilities in Japan



- Maintenance and Upgrading of various facilities are carried out in order to improve the asset value of hydropower plant, but the triggers are not solely dependent but are often influenced and closely related to each other . For implementation, power utilities are making decisions after analyzing and evaluating a plurality of triggers.
- As a primary arrangement, collected cases are classified into five main triggers and organized as shown in the figure.

(4) Trigger, Decision Making and Risk Management

Trigger	Decision Making						Risk Management				
							Yes				No
	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	
1. Aging Deterioration	14	35	17	0	4	2	56	16	0	0	0
(1) R&U of Turbine and Generators		*22*			*4*		*26*				
(2) Improvement of Civil Facilities	*14*	*13*	*17*				*28*	*16*			
(3) Abolition						*2*	*2*				
2. Disaster Recovery	7	3	34	0	0	0	19	25	0	0	0
(1) Earthquake	*7*	*1*	*6*				*7*	*7*			
(2) Flood & Heavy Rain		*2*	*17*				*5*	*14*			
(3) Public Safety			*11*				*7*	*4*			
3. Social Demand	0	0	10	0	11	2	14	9	0	0	0
(1) Environment			*9*					*9*			
(2) Sedimentation											
(3) Flood Control					*11*	*1*	*12*				
(4) Demand from Local Community			*1*			*1*	*2*				
4. Efficiency Improvement & Operation Review	0	1	9	0	0	0	8	2	0	0	0
(1) Increase Revenue			*2*				*1*	*1*			
(2) Labor Saving of Management		*1*					*1*				
(3) Operational Change			*7*				*6*	*1*			
5. Effective Utilization of Water Resources	0	0	2	13	29	0	0	0	0	0	44
(1) River Maintenance Flow Facilities				*8*	*6*						*14*
(2) Existing Hydropower Facilities			*2*	*5*	*7*						*14*
(3) The Others					*16*						*16*
Total	21	39	72	13	44	4 193	97	52	0	0	44 193

Remarks

Decision Making

A1: Maintenance & Repair, A2: Renewal & Upgrading, A3: Refurbishment, A4: Expansion, A5: Redevelopment, A6: Abolition

Risk Management

B1: Avoidance, B2: Decrease, B3: Transfer, B4: Acceptance

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2.2 Case Histories in USA, Canada and the others

Country		Collected information of Case Histories			
		Annex-XI	Hydro 2018	Site Vit	Sub total
Europe (19)	Norway	9	1		10
	Finland	1			1
	Austria		1		1
	France	1			1
	Switzerland	1	1		2
	Bulgaria		1		1
	Portugal		1		1
	Slovenia		1		1
	Poland		1		1
North and South America (38)	USA	7		14	21
	Canada			15	15
	Brazil	1	1		2
Pacific state (4)	Australia	2			2
	New Zealand	2			2
Asia (3)	China	1			1
	Korea		1		1
	India		1		1
Africa (2)	Zambia		1		1
	Kenya		1		1
Others (3)			3		3
	Total	25	15	29	69

2.3 Trends of collected Case Histories

a. Relation between Trigger and Decision Making

■ **Trends in case of Japan**

- Overall, "Refurbishment" is the largest, followed by "Redevelopment" and "Renewal & Upgrading".
- Ageing Deterioration: "Renewal & Upgrading is the largest.
- Disaster Recovery: "Refurbishment" is the largest.
- Social Demand: Occupied by "Redevelopment" and "Refurbishment".
- Efficiency Improvement & OR: Mostly "Refurbishment".
- Effective Utilization of WR: Redevelopment is the largest.

■ **Trends in case of USA, CA and the others**

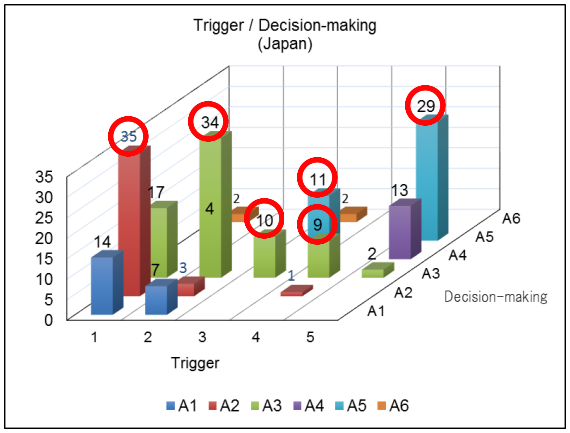
- Many of the collected cases are classified as "aging deterioration". There are few cases of "Disaster Recovery" and "Efficiency Improvement & Operation Review".
- Overall, "Renewal & Upgrading" is the largest, followed by "Refurbishment" and "Maintenance & Repair".

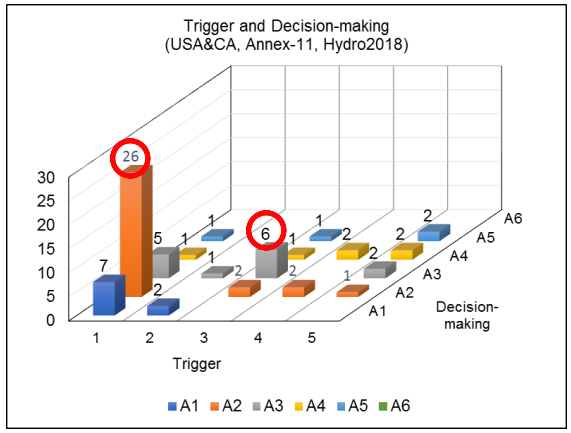
Trigger / Decision-making	A1	A2	A3	A4	A5	A6	Total
1 Aging Deterioration	14	35	17		4	2	72
2 Disaster Recovery	7	3	34				44
3 Social Demand			10		11	2	23
4 Efficiency Improvement & Operation Review		1	9				10
5 Effective Utilization of Renewable Energy			2	13	29		44
Total	21	39	72	13	44	4	193

Remarks
A1: Maintenance & Repair, A2: Renewal & Upgrading, A3: Refurbishment
A4: Expansion, A5: Redevelopment, A6: Abolition, A7: Others

Trigger / Decision-making	A1	A2	A3	A4	A5	A6	A7	Total
1 Aging Deterioration	7	26	5	1	1		4	44
2 Disaster Recovery	2		1					3
3 Social Demand		2	6	1	1		1	11
4 Efficiency Improvement & Operation Review		2		2				4
5 Effective Utilization of Renewable Energy		1	2	2	2			7
Total	9	31	14	6	4		5	69

Remarks
A1: Maintenance & Repair, A2: Renewal & Upgrading, A3: Refurbishment
A4: Expansion, A5: Redevelopment, A6: Abolition, A7: Others





b. Relation between Trigger and Risk Management

■ **Trends in case of Japan**
- Overall, "Avoidance" is the largest.
- Aging Deterioration, Social Demand and Efficiency Improvement: "Avoidance" is the largest.
- Disaster Recovery: "Decrease" is the largest.
- Effective Utilization of Water Resources: organized as out of risk management target.

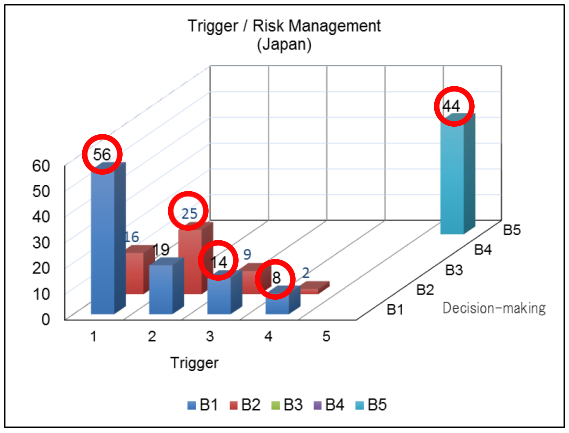
■ **Trends in case of USA, CA and the others**
- Overall, "Decrease" is larger than "Avoidance".
- Aging Deterioration and Social Demand: "Decrease" is the largest.
- Effective Utilization of Water Resources: organized as out of risk management target.

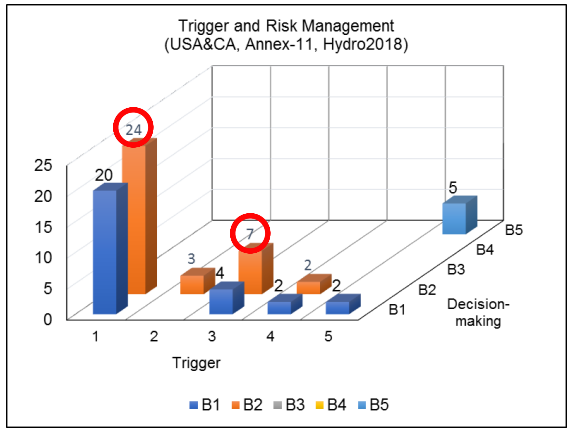
Trigger / Risk Management	B1	B2	B3	B4	B5	Total
1 Aging Deterioration	56	16				72
2 Disaster Recovery	19	25				44
3 Social Demand	14	9				23
4 Efficiency Improvement & Operation Review	8	2				10
5 Effective Utilization of Renewable Energy					44	44
Total	97	52			44	193

Remarks
B1: Avoidance, B2: Decrease, B3: Transfer, B4: Acceptance, B5: -

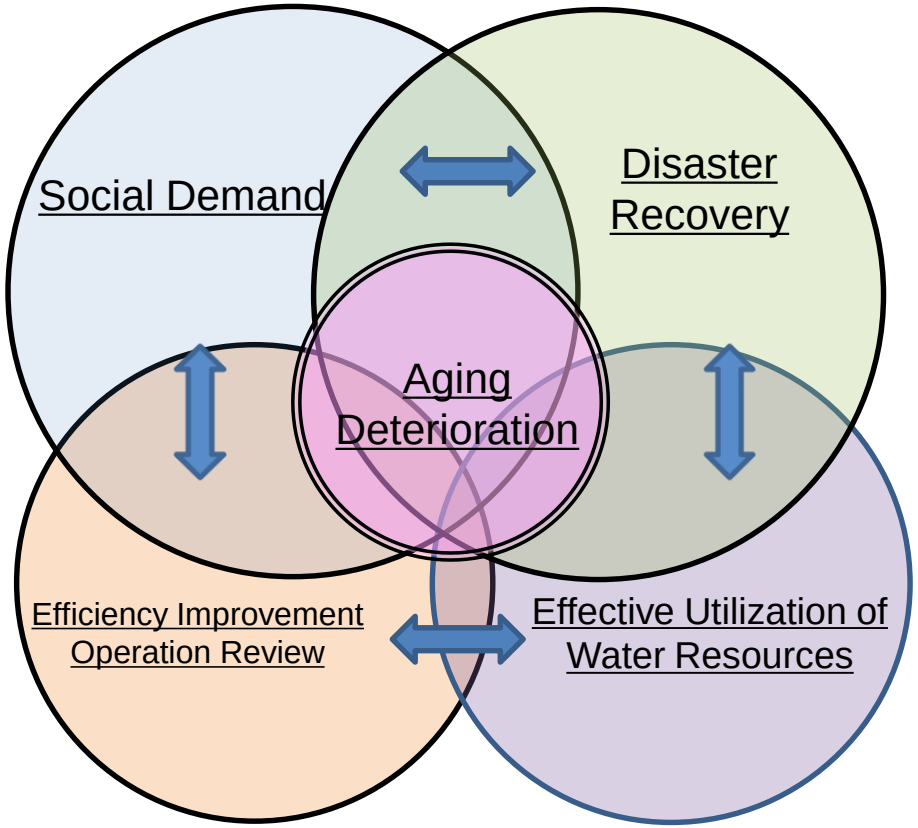
Trigger / Risk Management	B1	B2	B3	B4	B5	Total
1 Aging Deterioration	20	24				44
2 Disaster Recovery		3				3
3 Social Demand	4	7				11
4 Efficiency Improvement & Operation Review	2	2				4
5 Effective Utilization of Renewable Energy	2				5	7
Total	28	36			5	69

Remarks
B1: Avoidance, B2: Decrease, B3: Transfer, B4: Acceptance, B5: -





3. Idea / Concept of future case analysis



■ Value of Hydropower
Base (kWh)
⇒ Peak supply (kW)
⇒ Ancillary
Facilities have been improved accordingly.

■ Value of River Water
Preventive maintenance against disaster
Power
⇒ Flood Control and Environmental Conservation

■ Keyword of Decision-making for Maintenance Works & Upgrading of Hydro Utilities in Japan

- Compliance
- Preventive Maintenance
  - ・Disaster risk reduction measures
  - ・Cooperation for flood control
  - ・Measures against turbid water
  - ・Public safety, etc.

Thank you for your attention.