

KORIŠTENJE VODNIH SNAGA

STROJARNICE

Uvod

- STROJARNICA – u širem smislu
 - Skup građevina i opreme koja se koristi za pretvaranje energije vode u električnu energiju i njenu predaju u distribucijsku mrežu

- Položaj – dispozicija – strojarnice ovisi o cjelokupnom rješenju HE i definira se na osnovi koncepcije korištenja energije vodotoka, lokalnim uvjetima i ekonomskim karakteristikama rješenja

Uvod

- STROJARNICA – u širem smislu
 - Skup građevina i opreme koja se koristi za pretvaranje energije vode u električnu energiju i njenu predaju u distribucijsku mrežu
- Dispozicija ovisi o:
 - Cjelokupnom rješenju postrojenja i terenskim uvjetima
 - Uvjetima privoda i odvoda vode
 - Tipu HE
 - Veličini, tipu i broju agregata
 - Specijalnim uvjetima
 - Elektrostrojarskom rješenju

Uvod

- Oprema u sklopu strojarnice
 - TURBINA/e - osnovni proizvodni stroj
 - Definiira osnovne dimenzije strojarnice i njen visinski položaj
 - GENERATORI
 - TRANSFORMATORI
 - RASKLOPNO POSTROJENJE
 - UREĐAJI UPRAVLJANJA, ZAŠTITE I DOJAVE
 - POMOĆNI UREĐAJI
 - Vlastita potrošnja
 - Rashladni i drenažni sustav
 - Dizalice i unutarnji transport
 - Opskrba komprimiranim zrakom i sl.

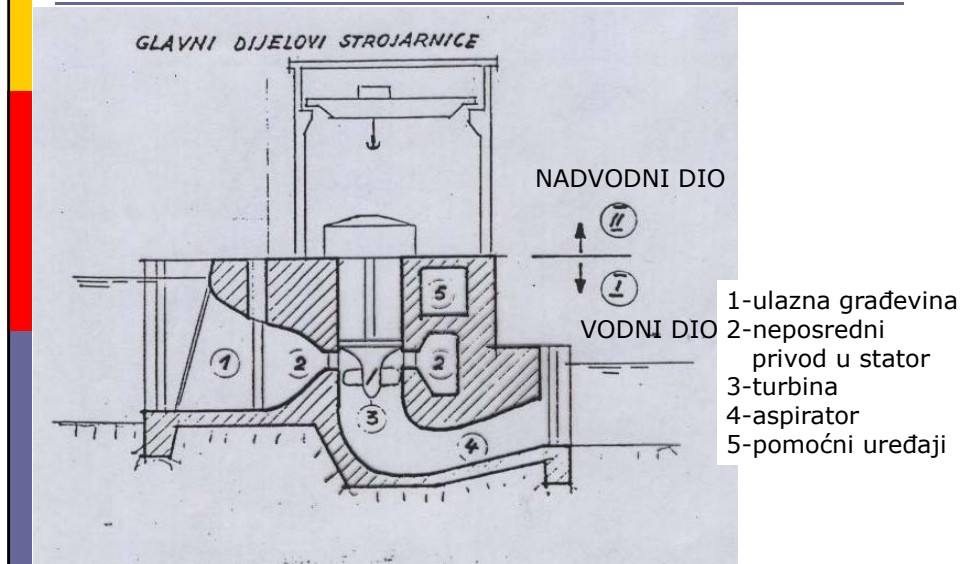
Dispozicija i rješenja

- Prema padu
 - niskotlačne
 - srednjetlačne
 - visokotlačne
- Prema rješenju zgrade strojarnice
 - Konvencionalne - površinske
 - Podzemne
 - U oknu
- Prema položaju osi turbine
 - s vertikalnom osi
 - s vodoravnom osi
 - s kosom osi

NISKOTLAČNE HE

- Pad do 30m
- Pribranska ili derivacijska
- Zgrada strojarnice dio brane ili se nalazi na derivaciji, te se konstruira i izvodi kao i brana
- U pravilu površinske
- Prema položaju osi turbine
 - s vertikalnom osi
 - s vodoravnom osi
- Obzirom na pad koriste se cijevne i Kaplan turbine

NISKOTLAČNE HE



NISKOTLAČNE HE – nadvodni dio strojarnice

- STROJARNICA u užem smislu
 - Generatori
 - Ev. turbine (s horizontalnom osovinom)
 - Regulatori turbina s uređajem za pogon tlačnim uljem
 - Agregati za uzbuđenje glavnih generatora
 - Pomoćni uređaji
 - Pokretna dizalica
- MONTAŽNI PROSTOR
- TRANSFORMATORI
- RASKLOPNO POSTROJENJE
- KOMANDNI PROSTOR
- POMOĆNE PROSTORIJE

NISKOTLAČNE HE – strojarnica

- Ovisno o položaju osi turbine
 - Vertikalna os – najčešće – prednosti
 - Niski položaj turbine
 - Povoljan privod vode
 - Visok položaj generatora
 - Uži mašinski prostor
 - Horizontalna os
 - U situaciji mogući položaji
 - Okomito na os zgrade
 - Paralelno s osi zgrade
 - Koso na os zgrade

NISKOTLAČNE HE - dispozicija

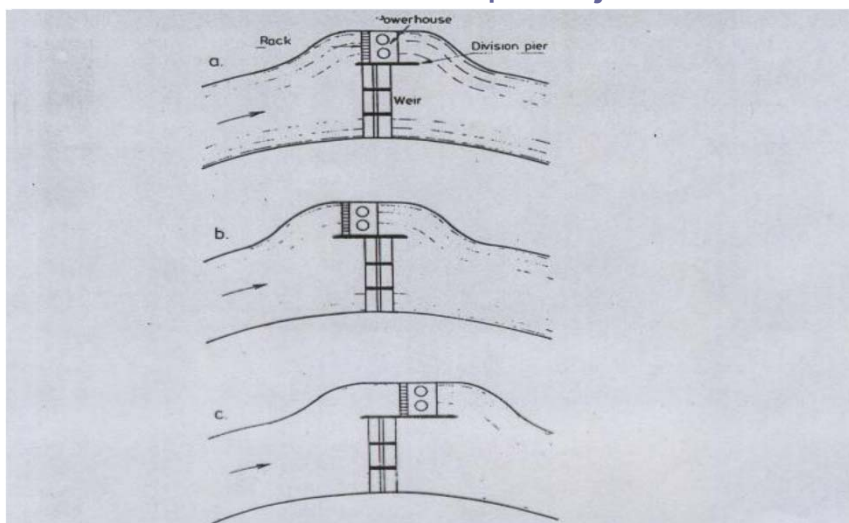


Fig. 16/34. Relative positions of powerhouse and weir; a) powerhouse in line with the weir, b) powerhouse set upstream, c) powerhouse set downstream

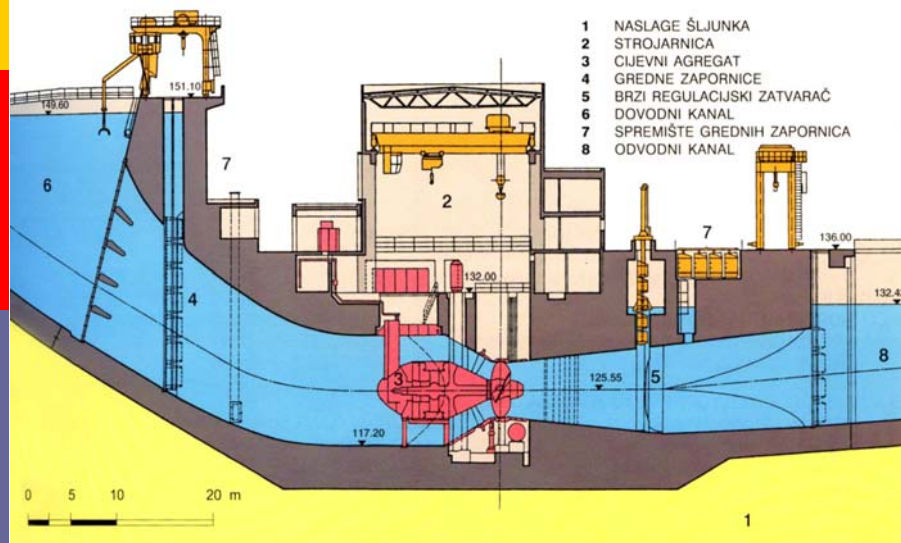
NISKOTLAČNE HE - HE Dubrava



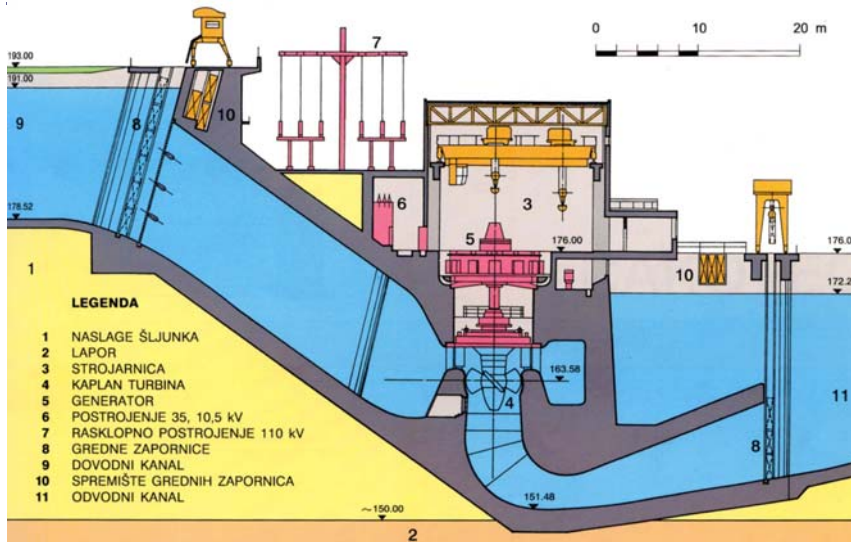
NISKOTLAČNE HE - HE Dubrava

LEGENDA

- 1 NASLAGE ŠLJUNKA
- 2 STROJARNICA
- 3 CIJEVNI AGREGAT
- 4 GREDNE ZAPORNICE
- 5 BRZI REGULACIJSKI ZATVARAČ
- 6 DOVODNI KANAL
- 7 SPREMIŠTE GREDNIH ZAPORNICA
- 8 ODVODNI KANAL



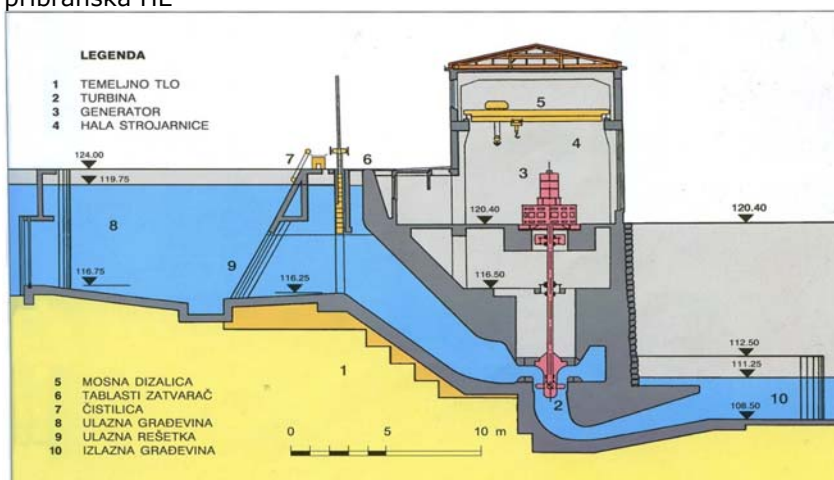
NISKOTLAČNE HE - HE Varaždin



HE Ozalj

Protočna,
pibranska HE

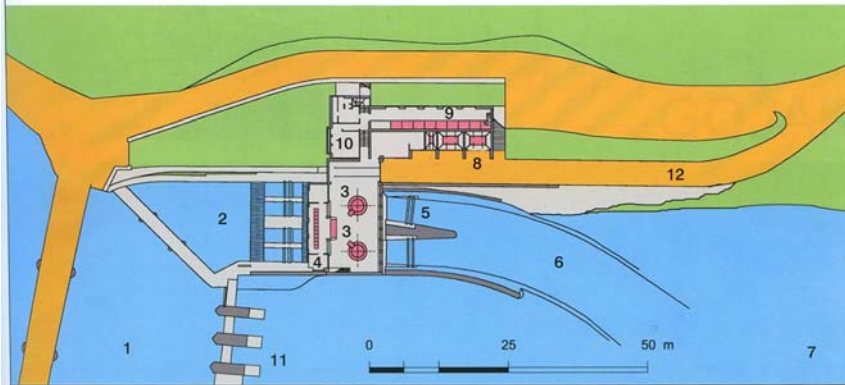
Kaplan t.-2x1,3MW



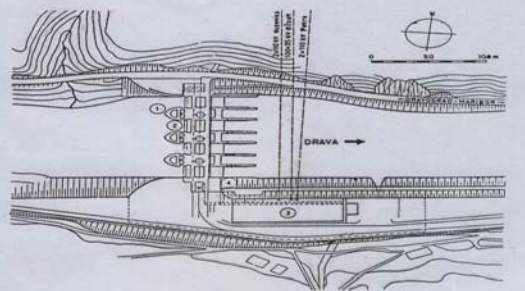
HE Ozalj

LEGENDA

- | | | | |
|---|----------------------|----|------------------------------|
| 1 | AKUMULACIJSKO JEZERO | 7 | KORITO KUPE |
| 2 | ULAZNA GRADEVINA | 8 | TRANSFORMATORSKO POSTROJENJE |
| 3 | AGREGATI | 9 | RASKLOPNO POSTROJENJE |
| 4 | KOMANDA | 10 | UPRAVA HIDROELEKTRANE |
| 5 | IZLAZNA GRADEVINA | 11 | PRELJEVNA GRADEVINA |
| 6 | ODVODNI KANAL | 12 | PRISTUPNA CESTA |

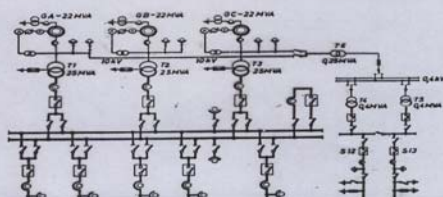


NISKOTLAČNE HE s agregatima u riječnim stupovima



Situacija

- | | |
|---------------------|----------------------|
| 1. Turbinski stoper | 3. Stikalište |
| 2. Pretočno polje | 4. Upravno posloplje |



NISKOTLAČNE HE - preljevne HE

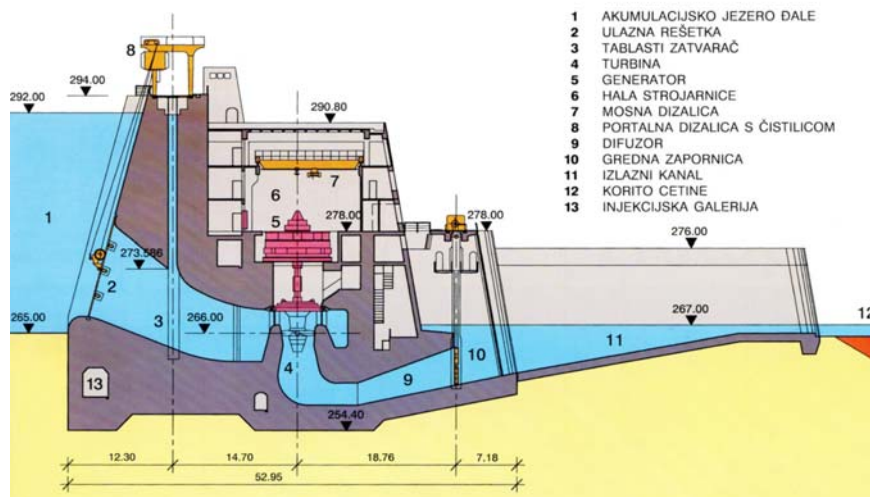
- Strojarnica je ugrađena u tijelo brane
- Turbine
 - Cijevne
 - Kaplan ili propeler na horizontalnoj ili vertikalnoj osi

SREDNJETLAČNE HE - pribranske HE

- Brana i strojarnica u statičkom smislu nezavisni – dilatacijska spojnica
- Transformatori i prijenosni uređaji najčešće između brane i strojarnice
- Zbog kratkog dovoda nije neophodan predturbinski zatvarač
- Slapište brane se od izlaznog dijela iz turbine razdvaja zidom koji sprečava sekundarna strujanja i nepovoljan utjecaj na rad turbine
- Ovisno o padu ugrađuju se Kaplan, Francis ili dijagonalne turbine

HE Đale

pribranska HE
Kaplan t. 2x20,4MW

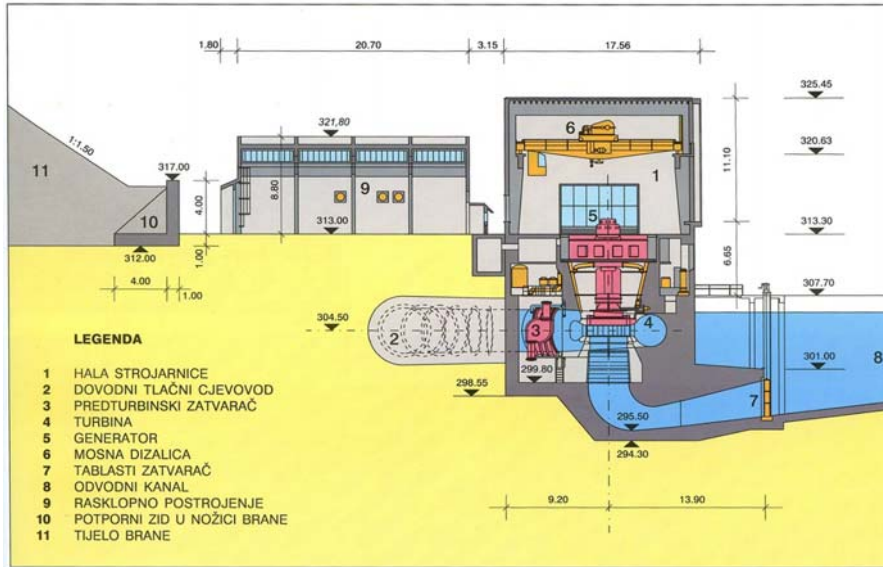


SREDNJETLAČNE I VISOKOTLAČNE HE

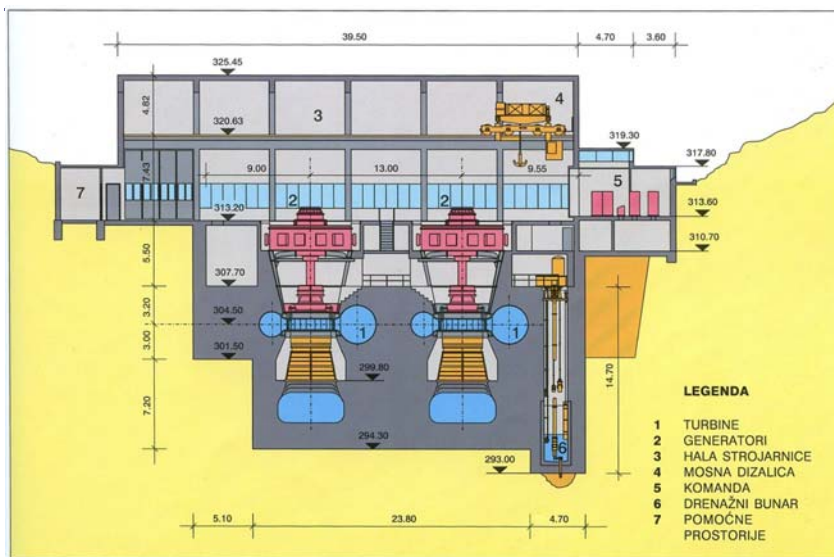
- Strojarnica je potpuno zasebna građevina koja je s ostalim građevinama HE povezana dovodom (najčešće tlačni cjevovod)
- Turbina – najčešće: Francis ili Pelton s vertikalnom ili horizontalnom osi
- U pravilu opremljena predturbinskim zatvaračem
- Dispozicija – NADZEMNE ILI PODZEMNE

HE Peruća

pribranska HE
Francis t. 2x21,3MW



HE Peruća

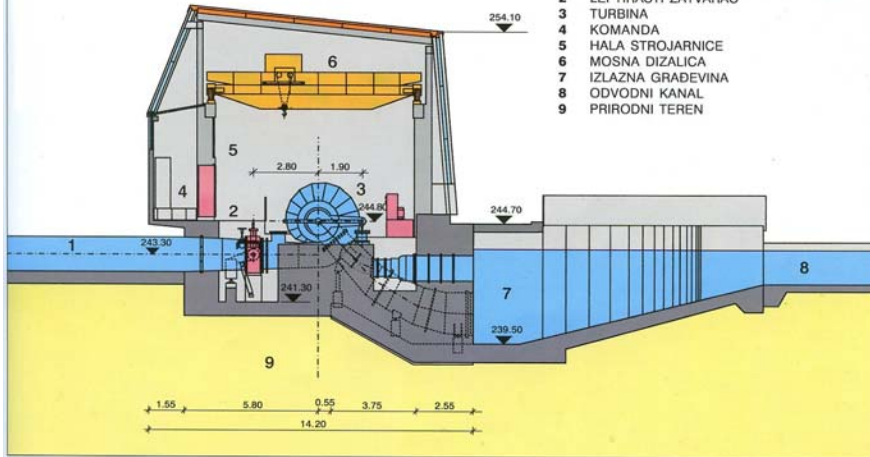


HE Golubić

visokotlačna,
derivacijska HE
Francis t. 2x3,75MW

LEGENDA

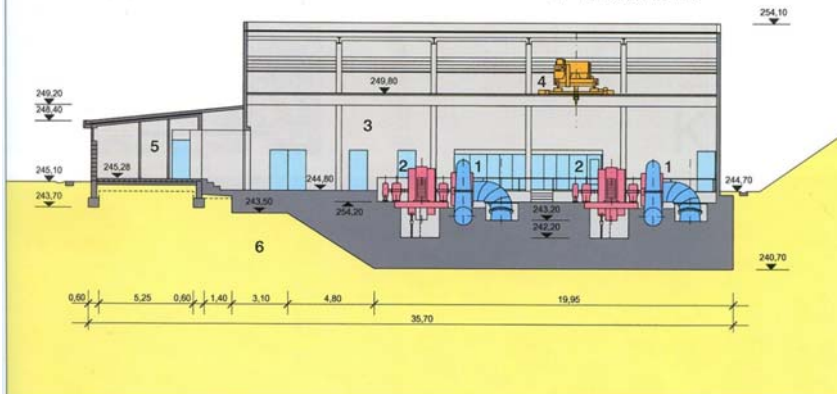
- 1 ČELIČNI TLAČNI CJEVOD
- 2 LEPTIRASTI ZATVARAČ
- 3 TURBINA
- 4 KOMANDA
- 5 HALA STROJARNICE
- 6 MOSNA DIZALICA
- 7 IZLAZNA GRAĐEVINA
- 8 ODVODNI KANAL
- 9 PRIRODNI TEREN



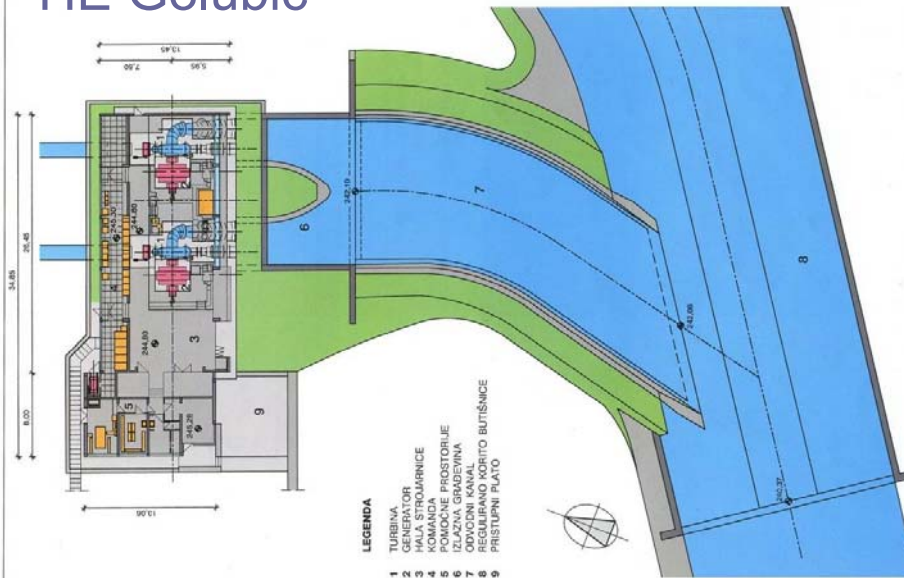
HE Golubić

LEGENDA

- 1 TURBINA
- 2 GENERATOR
- 3 HALA STROJARNICE
- 4 MOSNA DIZALICA
- 5 POMOĆNE PROSTORIJE
- 6 PRIRODNI TEREN

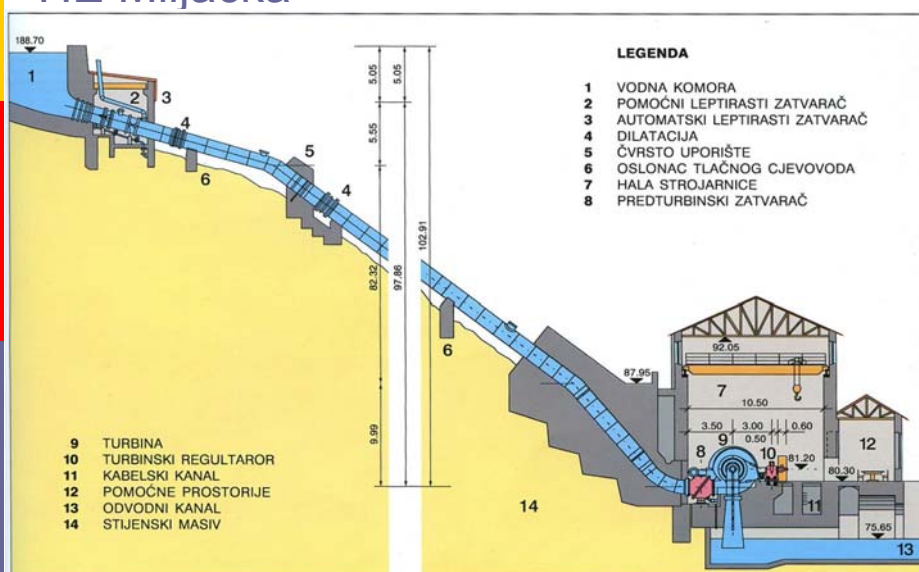


HE Golubić

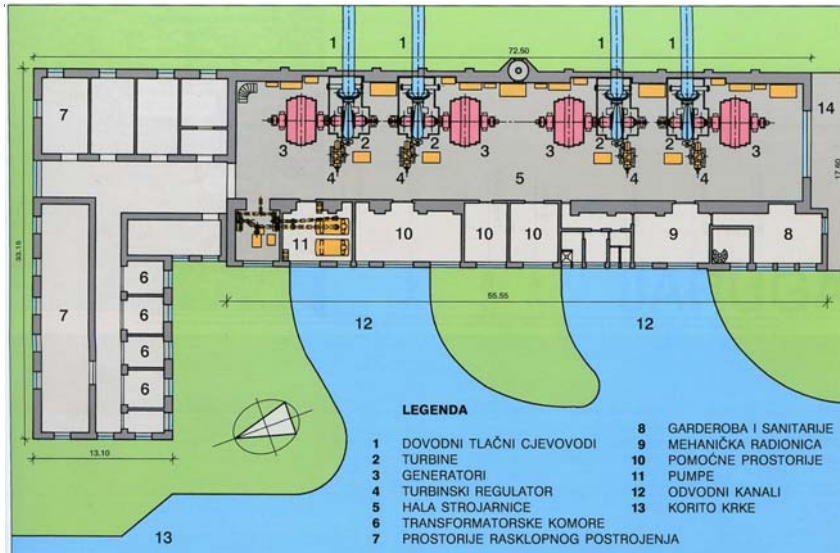


HE Miljacka

visokotlačna, derivacijska HE
Francis t. 3x6,7MW i 1x4,0MW

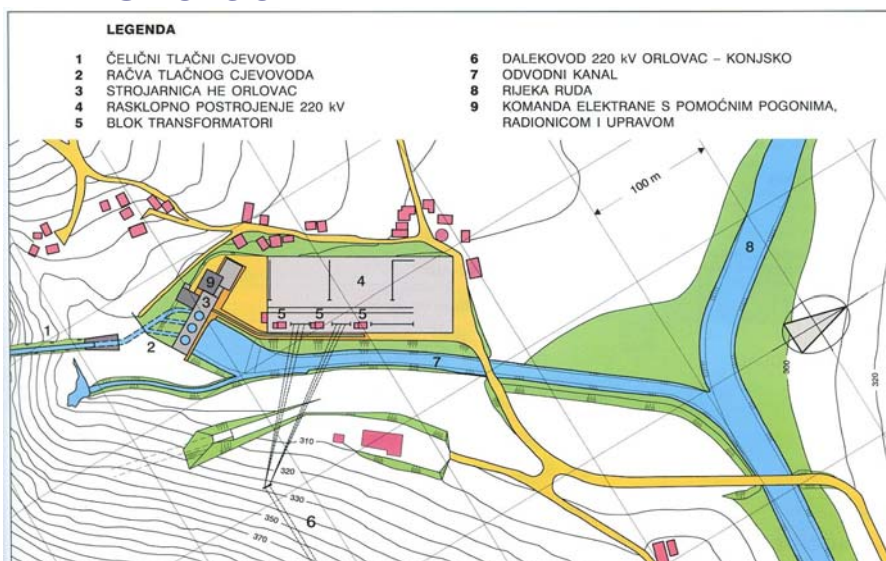


HE Miljacka

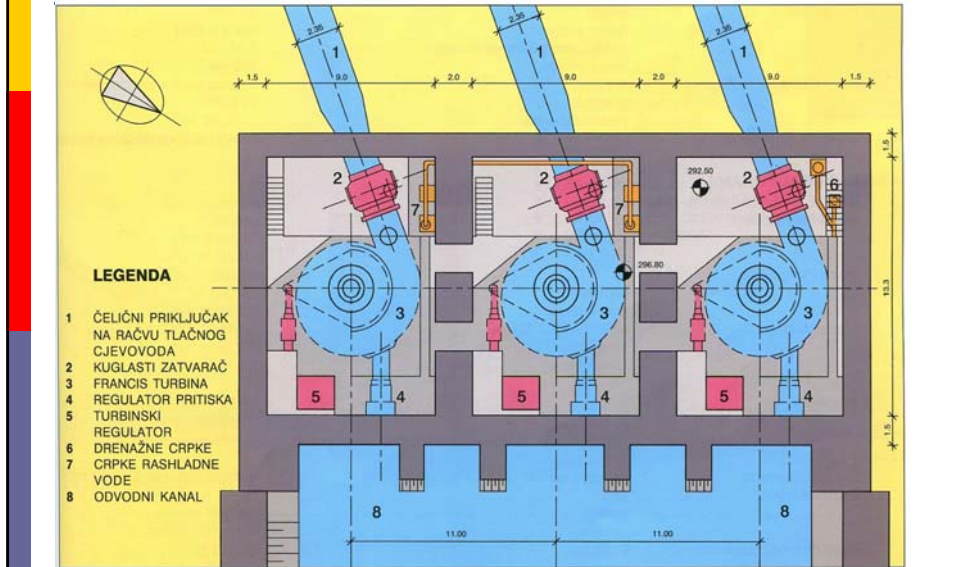


HE Orlovac

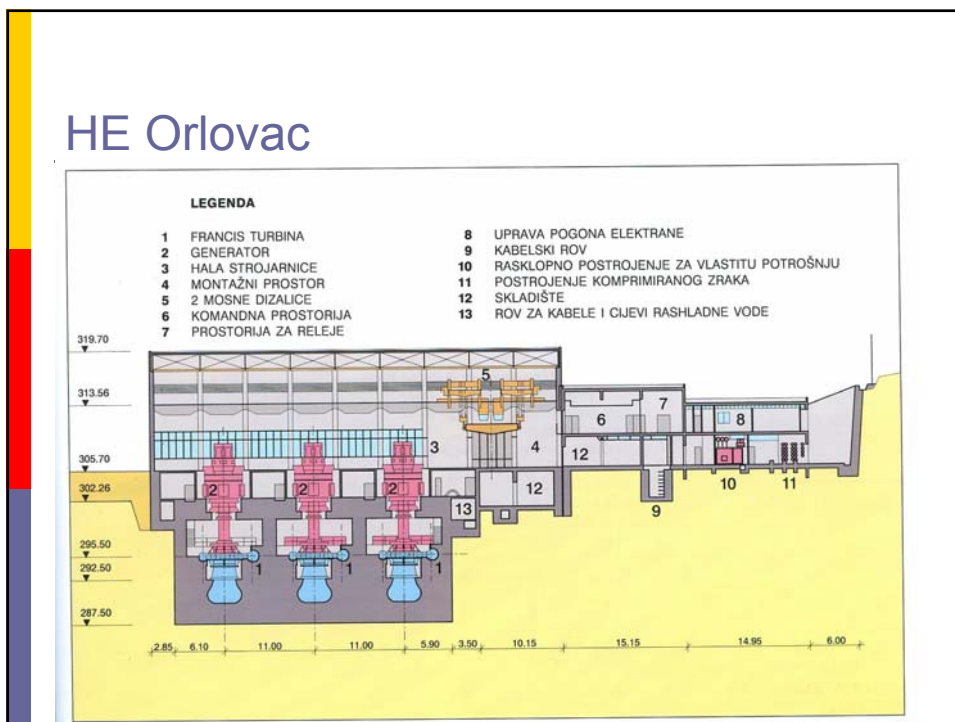
visokotlačna,
derivacijska HE
Francis t. 3x79MW



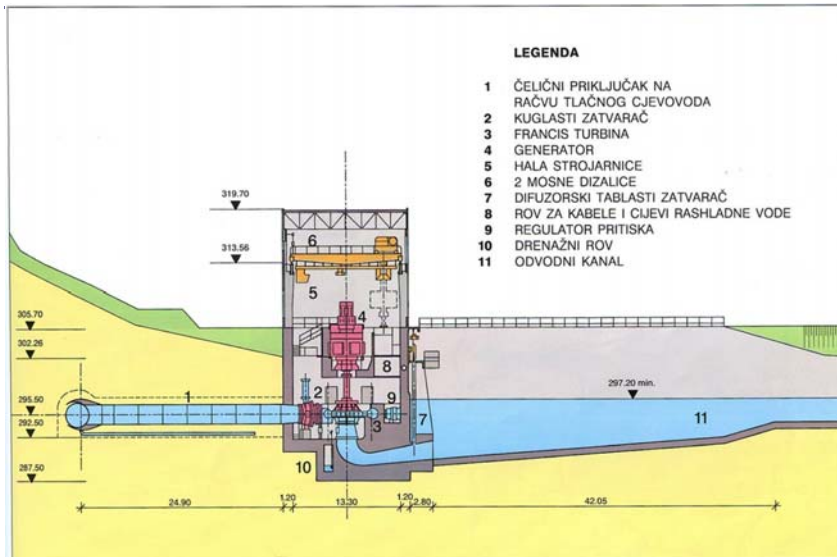
HE Orlovac



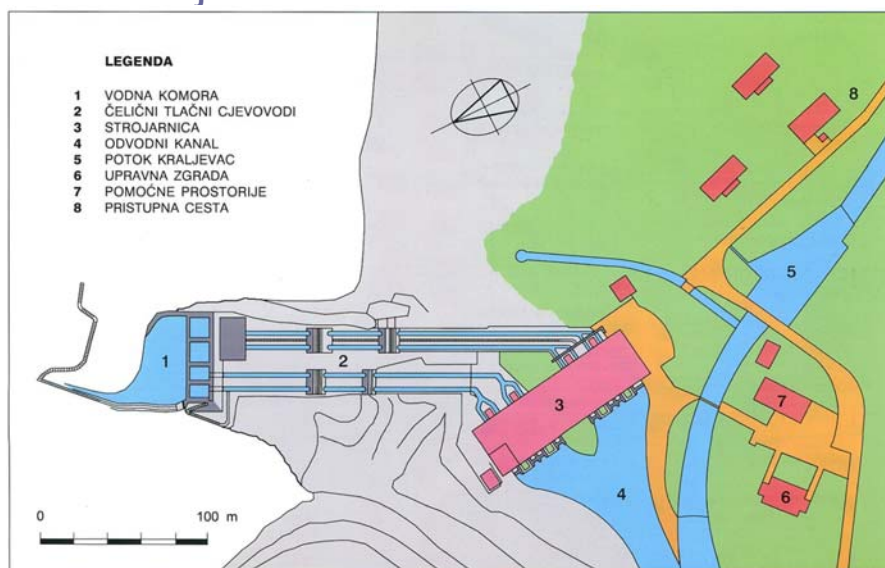
HE Orlovac



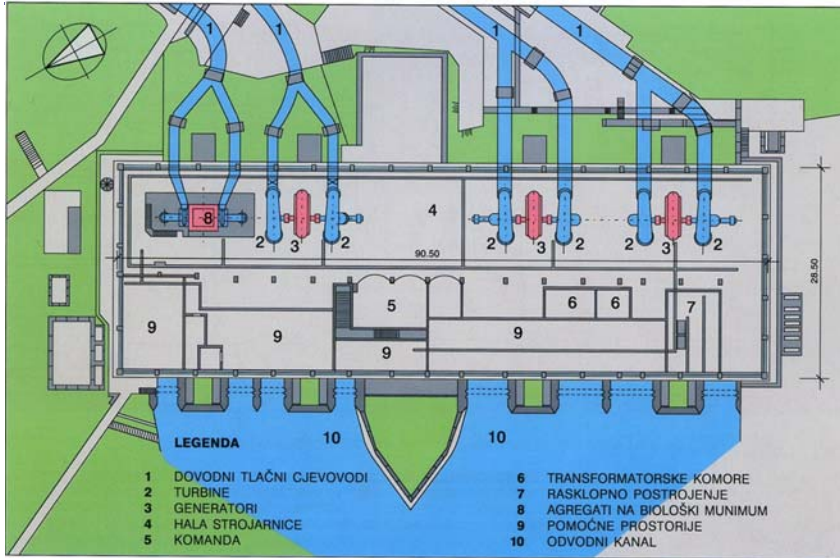
HE Orlovac



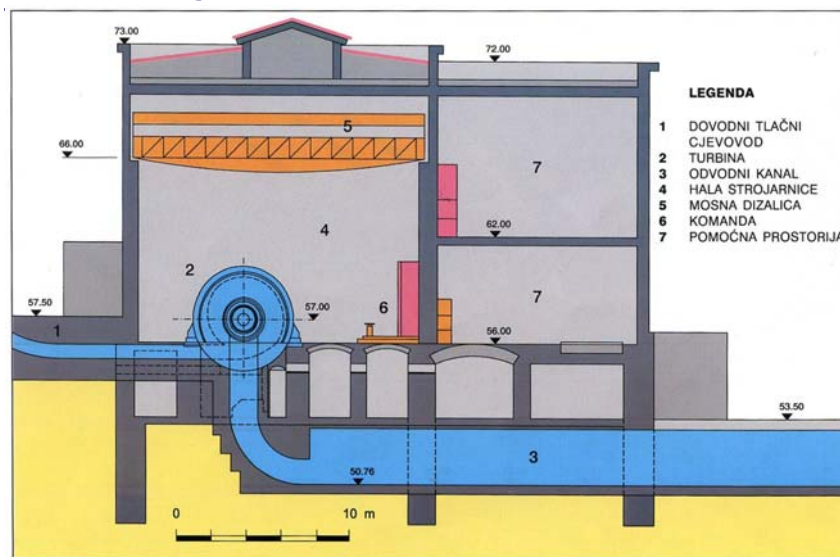
HE Kraljevac



HE Kraljevac



HE Kraljevac

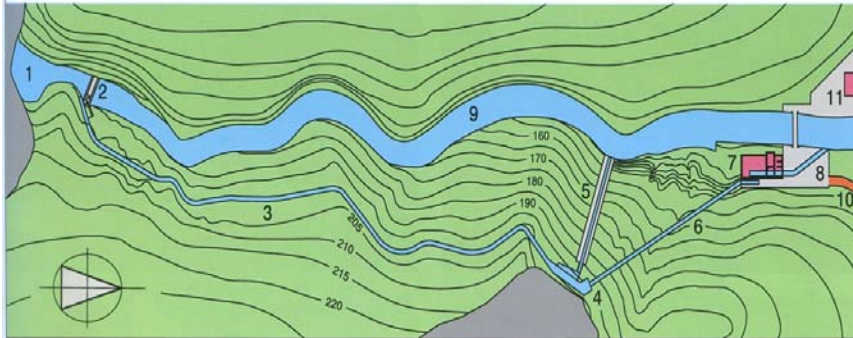
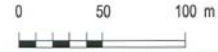


HE Zeleni vir

Visokotlačna derivacijska HE
Francis spiralna t.-2x0,9MW

LEGENDA

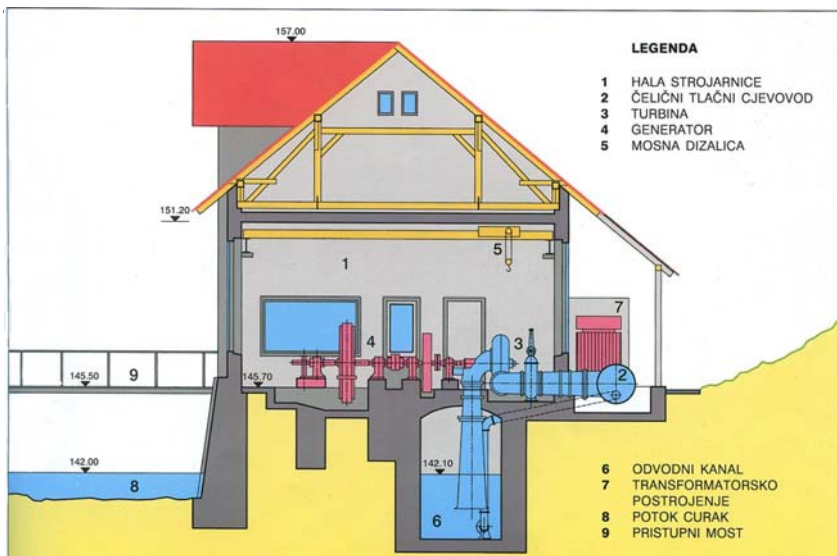
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|---|---------------------------|----|---------------------------|
| 1 | IZVORSKO JEZERCE U ŠPILJI | 6 | ČELIČNI TLAČNI CJEVOVOD |
| 2 | ZAHVATNA GRAĐEVINA | 7 | STROJARNICA |
| 3 | DOVODNI KANAL | 8 | ODVODNI KANAL |
| 4 | VODNA I ZASUNSKA KOMORA | 9 | POTOK ČURAK |
| 5 | PRELJEV | 10 | PRISTUPNA CESTA ELEKTRANI |
| | | 11 | PLANINARSKI DOM |



HE Zeleni vir

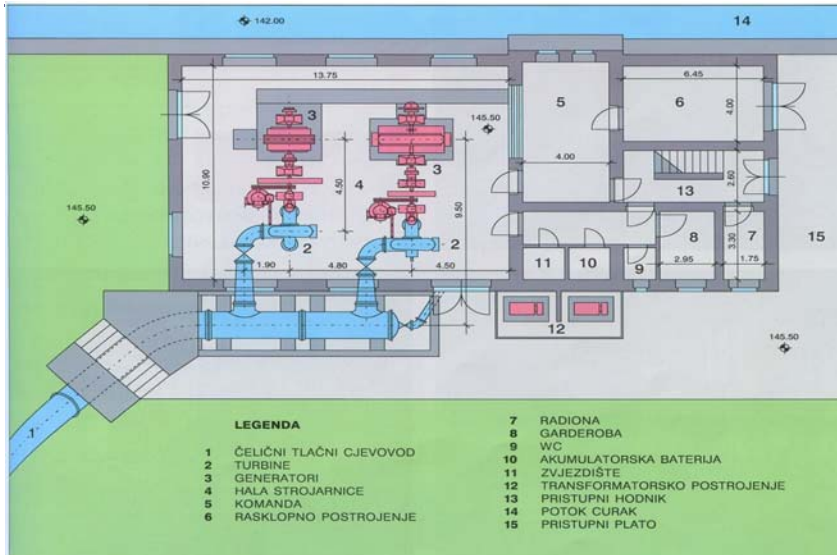
LEGENDA

- | | |
|---|-------------------------|
| 1 | HALA STROJARNICE |
| 2 | ČELIČNI TLAČNI CJEVOVOD |
| 3 | TURBINA |
| 4 | GENERATOR |
| 5 | MOSNA DIZALICA |

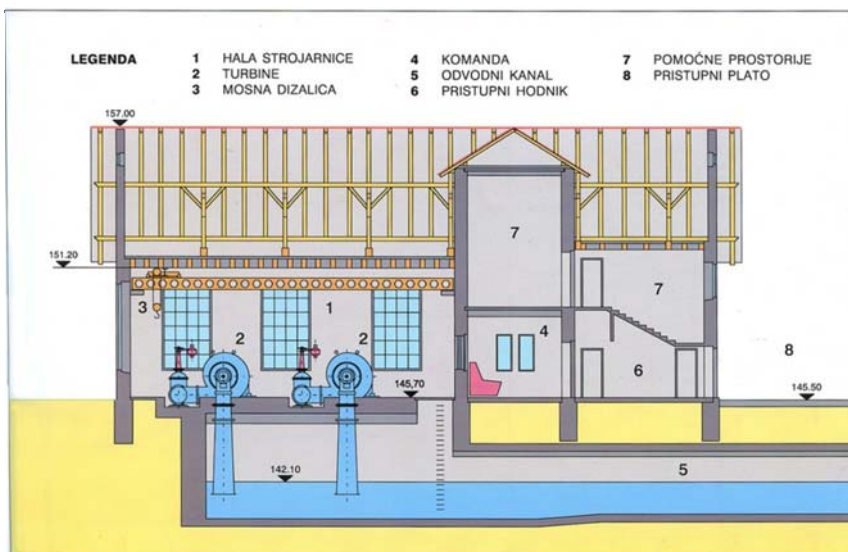


- | | |
|---|---------------------------------|
| 6 | ODVODNI KANAL |
| 7 | TRANSFORMATORSKO
POSTROJENJE |
| 8 | POTOK ČURAK |
| 9 | PRISTUPNI MOST |

HE Zeleni vir



HE Zeleni vir



PODZEMNE STROJARNICE

Geološki i hidrogeološki uvjeti

- Vrsta i struktura stijene
- Pad i pružanje slojeva
- Stanje podzemnih voda

Švedski tip

- TLAČNI DOVOD JE KRATAK
- BEZ GORNJE VODNE KOMORE
- ODVOD DUGAČAK
- Stijene male vodopropusnosti i izuzetno dobre geotehničke karakteristike

Švicarski- alpski ili dinarski tip

- TLAČNI DOVOD JE DUGAČAK
- VODNA KOMORA NA KRAJU DOVODA
- ODVOD KRATAK
- Vapnenačke stijene, masivi veće vodopropusnosti

Talijanski tip

Norveški tip

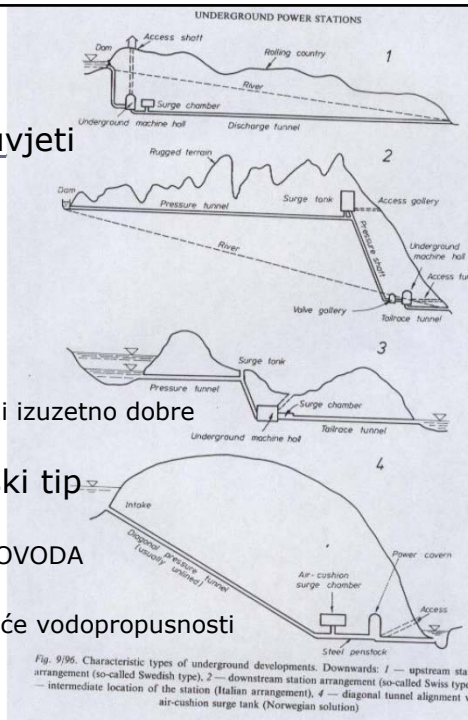
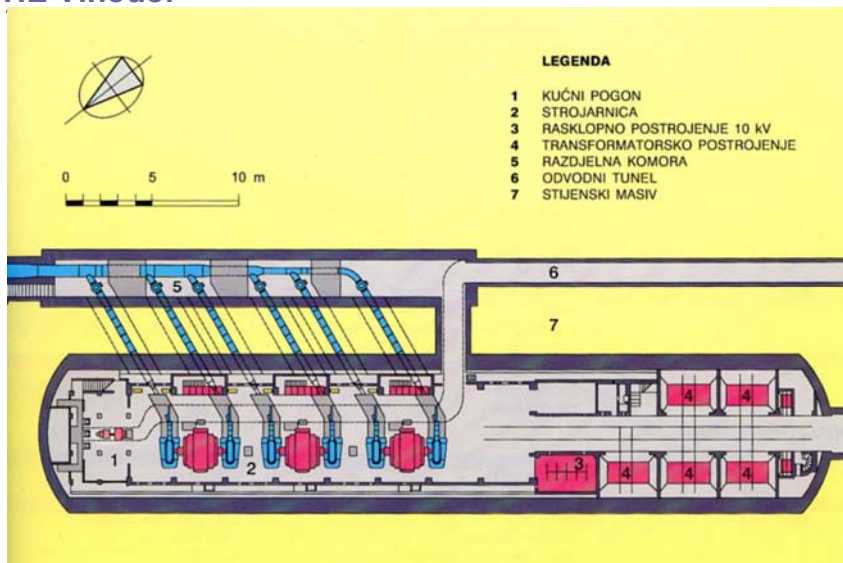
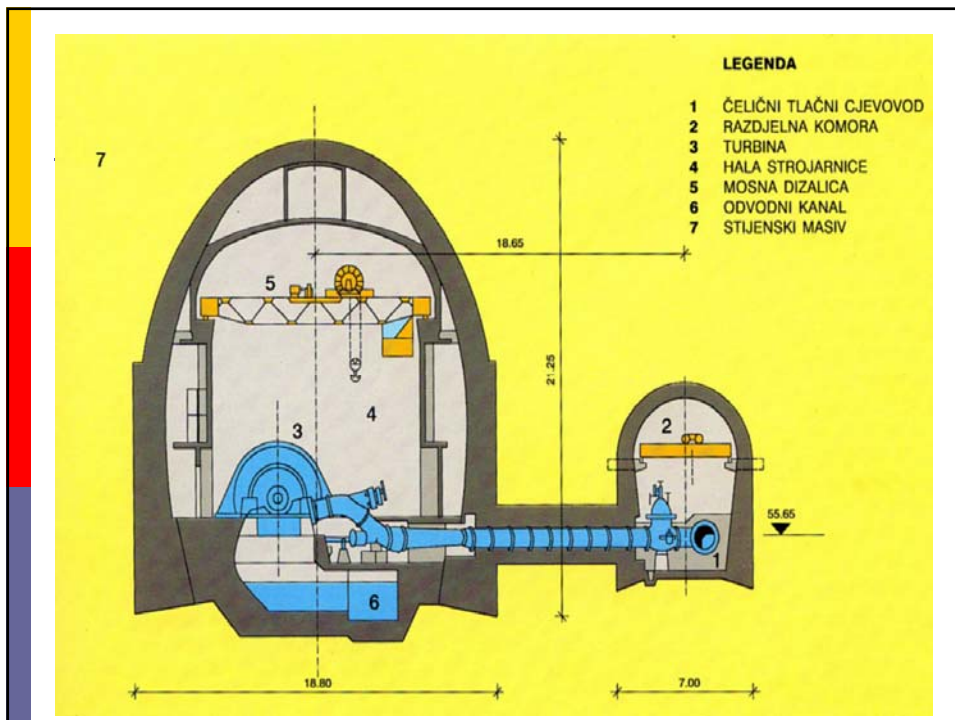
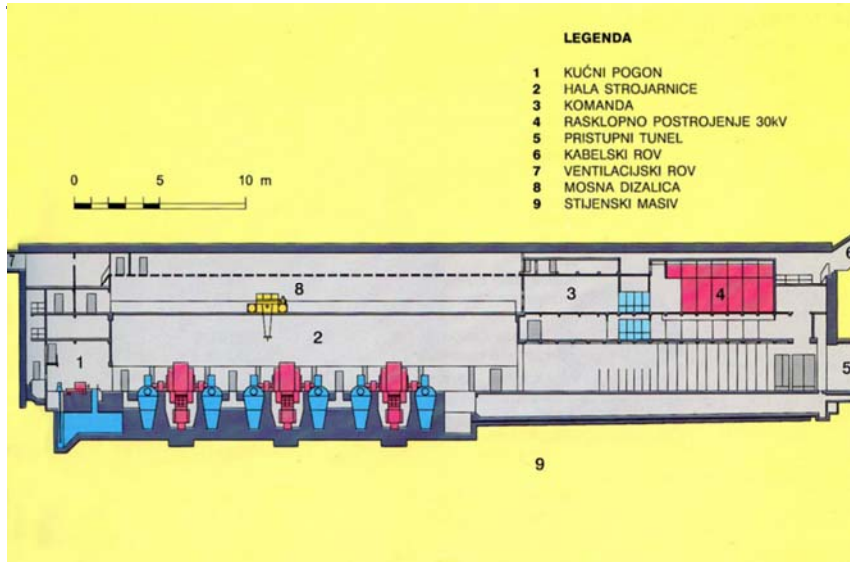


Fig. 9/96. Characteristic types of underground developments. Downwards: 1 — upstream station arrangement (so-called Swedish type), 2 — downstream station arrangement (so-called Swiss type), — intermediate location of the station (Italian arrangement), 4 — diagonal tunnel alignment with air-cushion surge tank (Norwegian solution)

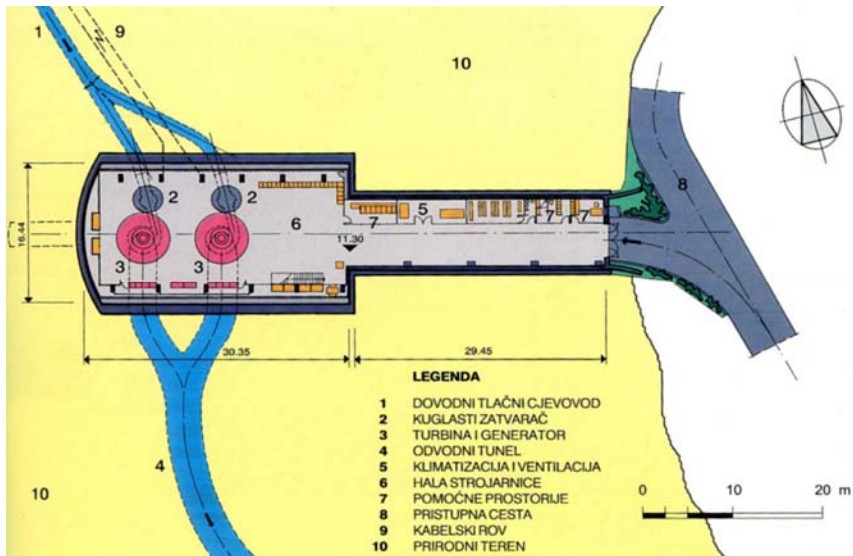
PODZEMNE STROJARNICE u RH HE Vinodol



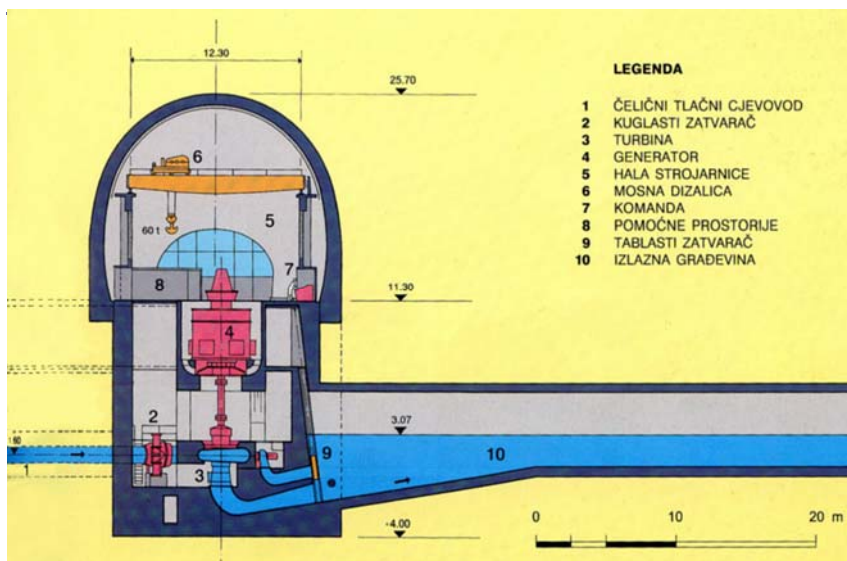
PODZEMNE STROJARNICE u RH HE Vinodol



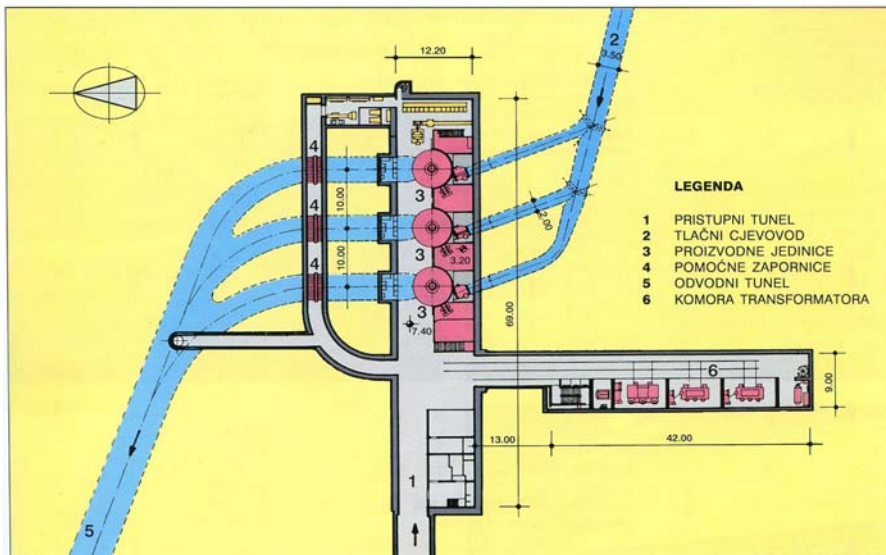
PODZEMNE STROJARNICE u RH – HE RIJEKA



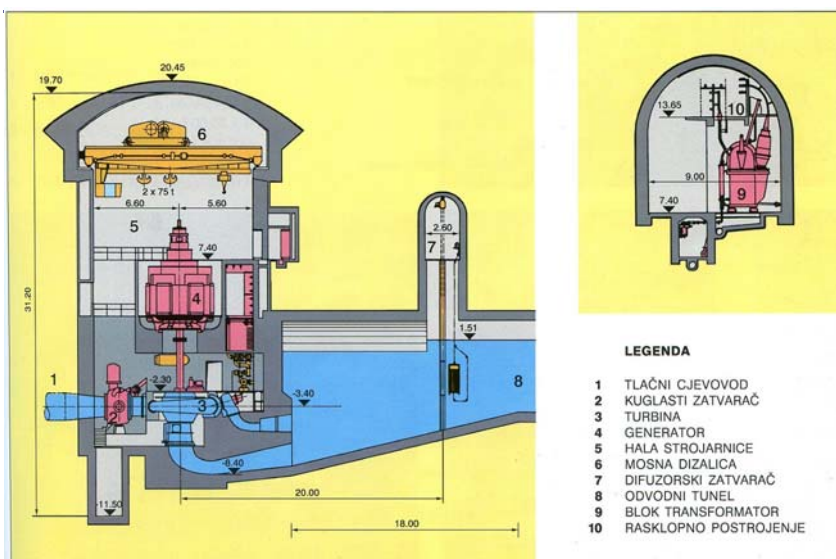
PODZEMNE STROJARNICE u RH – HE RIJEKA



PODZEMNE STROJARNICE u RH – HE SENJ

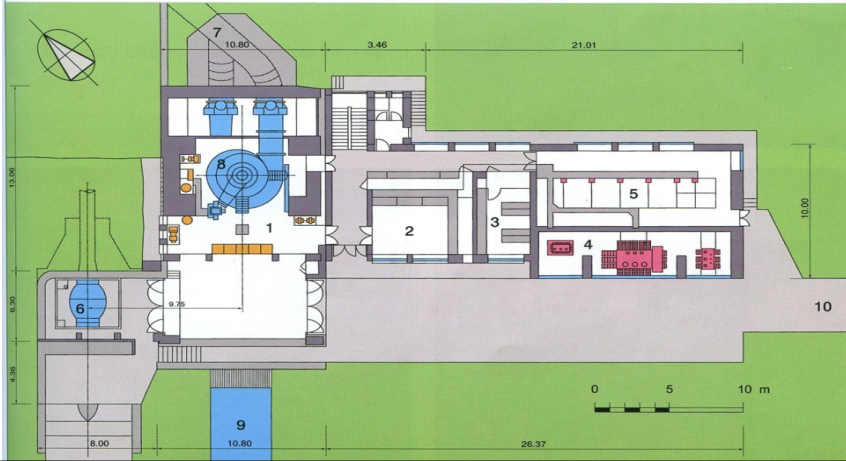


PODZEMNE STROJARNICE u RH – HE SENJ



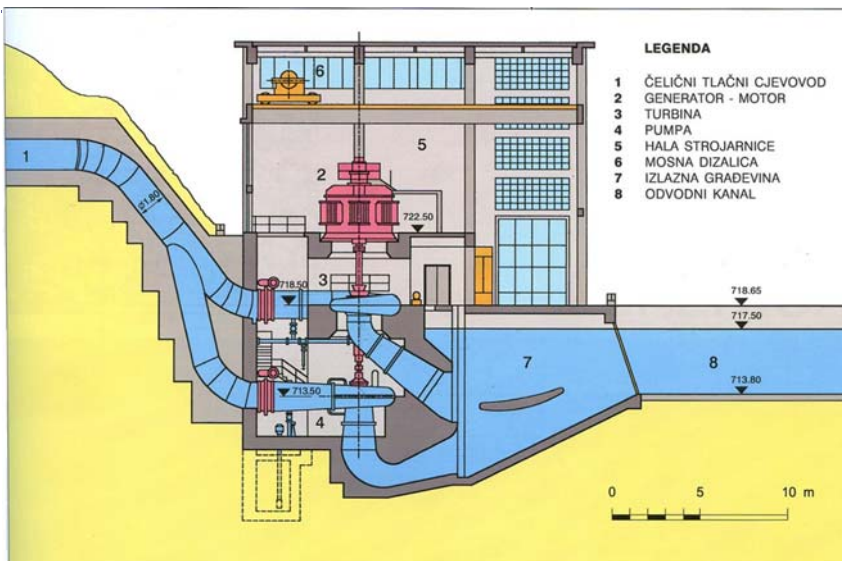
REVERZIBILNE HE – HE FUŽINE

- | | |
|--------------------------------|---------------------------|
| LEGENDA | |
| 1 HALA STROJARNICE | 5 RASKLOPNO POSTROJENJE |
| 2 RADIONICE | 6 TEMELJNI ISPUST |
| 3 GARDEROBA | 7 ČELIČNI TLAČNI CJEVOVOD |
| 4 TRANSFORMATORSKO POSTROJENJE | 8 TURBINA |
| | 9 ODVODNI KANAL |
| | 10 PRISTUPNA CESTA |



REVERZIBILNE HE – HE FUŽINE

- | | |
|---------------------------|---------------------|
| LEGENDA | |
| 1 ČELIČNI TLAČNI CJEVOVOD | 5 HALA STROJARNICE |
| 2 GENERATOR - MOTOR | 6 MOSNA DIZALICA |
| 3 TURBINA | 7 IZLAZNA GRADEVINA |
| 4 PUMPA | 8 ODVODNI KANAL |



REVERZIBILNE HE – HE FUŽINE

