



Structural Appraisal of Bradford Interchange Bus Station

B2382824-JAC-S-R-XXX-001

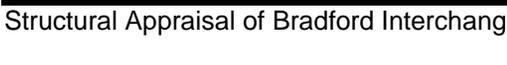
22 January 2024

West Yorkshire Combined Authority

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1.0 Introduction

West Yorkshire Combined Authority (WYCA) has engaged Jacobs to undertake a structural survey of Bradford Interchange Bus Station, Bradford BD1 1TU.

Jacobs was informed that a small concrete has been dislodged from the underside of the car park floor.

The bus station building is approximately 118 m x 24 m. The bus station building is supported off the underground car park columns.

This report will focus on the assessment of the car park floor slab, stairs and [REDACTED] bus station. The activities to be covered include:

- Non- intrusive visual survey of the car park floor slab, stairs and [REDACTED] and bus station with the objective of recording visible signs of deterioration to structural elements.

2.0 Survey

Jacobs carried out a non-intrusive visual inspection of the bus station building and car park on 12th January 2023. There was no rain on the day and temperature range was approximately 3 - 5^o C.

The car park floor is a beam and slab reinforced concrete construction. The bus station building is above the car park with tarmac surfacing and paving bricks/slabs around the perimeter of the bus station building. The bus station building roof is constructed of steel trusses spanning over columns.

Access to the underside of the car park slab was made with a MEWP.

All the defects will be identified and recorded, and recommendations will be made on the methods of repair.

Car park construction

Slab assumed to be between 150 mm – 200 mm.

Secondary beam depth from slab soffit – 722 mm

Main beam depth from slab soffit – approx. 875 mm

Columns – 1500 mm x 750 mm

Column spacing – approx. 22 m x 19.5 m

Height to soffit of slab – approx. 7 m

Drawings can be found in Appendix A. The on-site taken photos can be found in Appendix B.

3.0 Summary of survey findings

Location	Defect	Possible cause	Initial recommendations to be confirmed by further investigation	Photo
Car park slab (Close to the red column)	Spalling of concrete with exposed rebar.	Paving works carried out above car park reinforced concrete slab. Water ingress through slab	Break out concrete approx. 1.2 m x 1.2 m and expose bottom reinforcement, brush reinforcement clean and apply NATCEM 35.	See photo 9
Car park beam (secondary beam close to the red column)	Spalling of concrete with exposed rebar	Unknown	Concrete to be broken out to expose complete bar to extent where no corrosion is present. Brush bar clean and apply NATCEM 35.	See photos 7
Car park beam (Main beam close to the red column)	Spalling of concrete with exposed rebar	Unknown	Concrete to be broken out to expose complete bar to extent where no corrosion is present. Brush bar clean and apply NATCEM 35.	See photo 8
Car park slab (Close to the green column)	White patches on underside of slab	Water ingress through slab	Remove any loose concrete and expose reinforcement. Apply NATCEM 35.	See photos 15 -16
Holes in slab but covered	White patches on underside of slab	Water ingress through slab	Holes are to be covered with dowel bars and concrete.	See photo 18
Slab joints	White patches on underside of slab	Water ingress through slab	Further investigation is required	See photos 10 -12
Pipe penetrations	White patches on underside of slab	Water ingress through slab	Further investigation is required	See photos 19 ,37, 40 and 48
Building at car park entrance	Damp	Water ingress	Further investigation is required	See photos 23 - 25
Car park beam at entrance	Damp	Water ingress	Further investigation is required	See photos 21
Bus station building stairs	Damp	Water ingress	Further investigation is required	See photos 32- 34

Car park slab

1. A few areas of white patches have been identified and can be found in the photos in Appendix B. They also form around the slab close to the main beams.
2. 3No. fire exit stairs are currently holding water which appears to come from the steel roof above and the bottom of roof structure. See photos 26 – 27.

Bus station building

3. Water ingress through the stairs wall. Water can be seen flowing through the joint.

Tarmac surface around perimeter of bus station building

4. The car park joint was not visible on the tarmac surface.

Pipe penetrations

5. [REDACTED] Structural elements at some pipe penetration locations are damp. Some pipes are rectangular in shape and are connecting to circular pipes.

Interface of NCP car park and bus station

6. A retaining wall exists in this area and further assessment is required as a roof abuts the NCP car park masonry wall. The NCP car park is a concrete frame building.

4.0 Conclusions

Car park slab

1. The beams and columns of the car park generally appear to be in good condition with no visible cracks. The [REDACTED] section of the car park was not assessed, and further investigation will be required for this section.
2. The white patches on the underside of the slab and on the beams are caused by water ingress as the top of slab is exposed to weather elements. Tarmac surfacing has recently been placed on top of the reinforced concrete slab. The white patches are formed as a result of efflorescence process where the salt in the concrete has been pushed out due to water ingress. A prolong process may corrode the reinforcement and lead to spalling of concrete due to expansion of reinforcement.

5.0 Indicative Recommendations

These recommendations are to be confirmed following further investigation and testing.

Car park slab

1. We understand the purpose of the net under the slab and we suggest that the net should be removed from the beams as the beams are deeper than the slab sections and we do not expect water ingress issues in these areas. After all works have been carried out on the exposed (outdoor) top part of the car park slab, we suggest that the net is removed from the slab and beams. Should this suggestion be accepted, we recommend regular monitoring of the slab in the future by checking for any white patches or damp on the slab. A net should be used locally as a temporary protection during any works on top of the slab. The net obscures vision from the ground floor and makes it difficult to see any defects on the slab.
2. Indicative method of repair – slab
 - Area of repair to be 1.2 m x 1.2 m. See photo 9.
 - Contractor to carefully break out concrete in the specified area and expose the bottom reinforcement.
 - Contractor to confirm that there are no vertical cracks in the slab.
 - Contractor is to brush reinforcement and apply NATCEM 35 in accordance with manufacturer's specifications.
 - Data sheet can be found in Appendix C.
3. Indicative method of repair – slab joint

Further investigation will be required to assess the extent of the joint.
4. Indicative method of repair – beam

Repair will be similar to slab repair.

5. Additional investigation will include assessment of pipe penetrations [REDACTED]. Testing will include chlorides, sulphates and carbonation.

Bus station building stairs

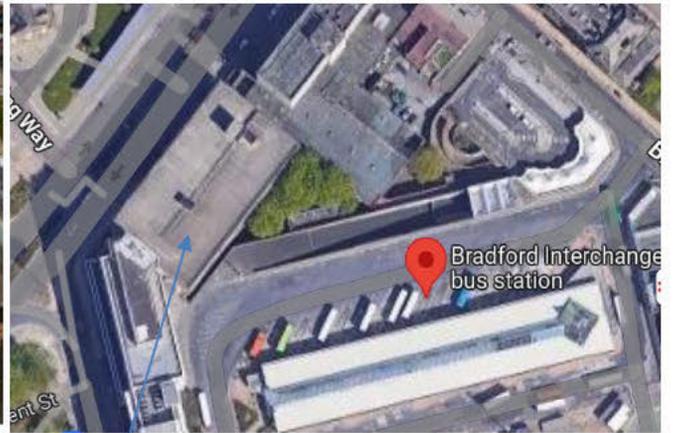
6. Further investigation will be required to assess the locations of the water ingress. Tiles are to be removed in the affected areas.
7. Extent of structural inspection is to cover the whole area owned by WYCA.

Appendix A

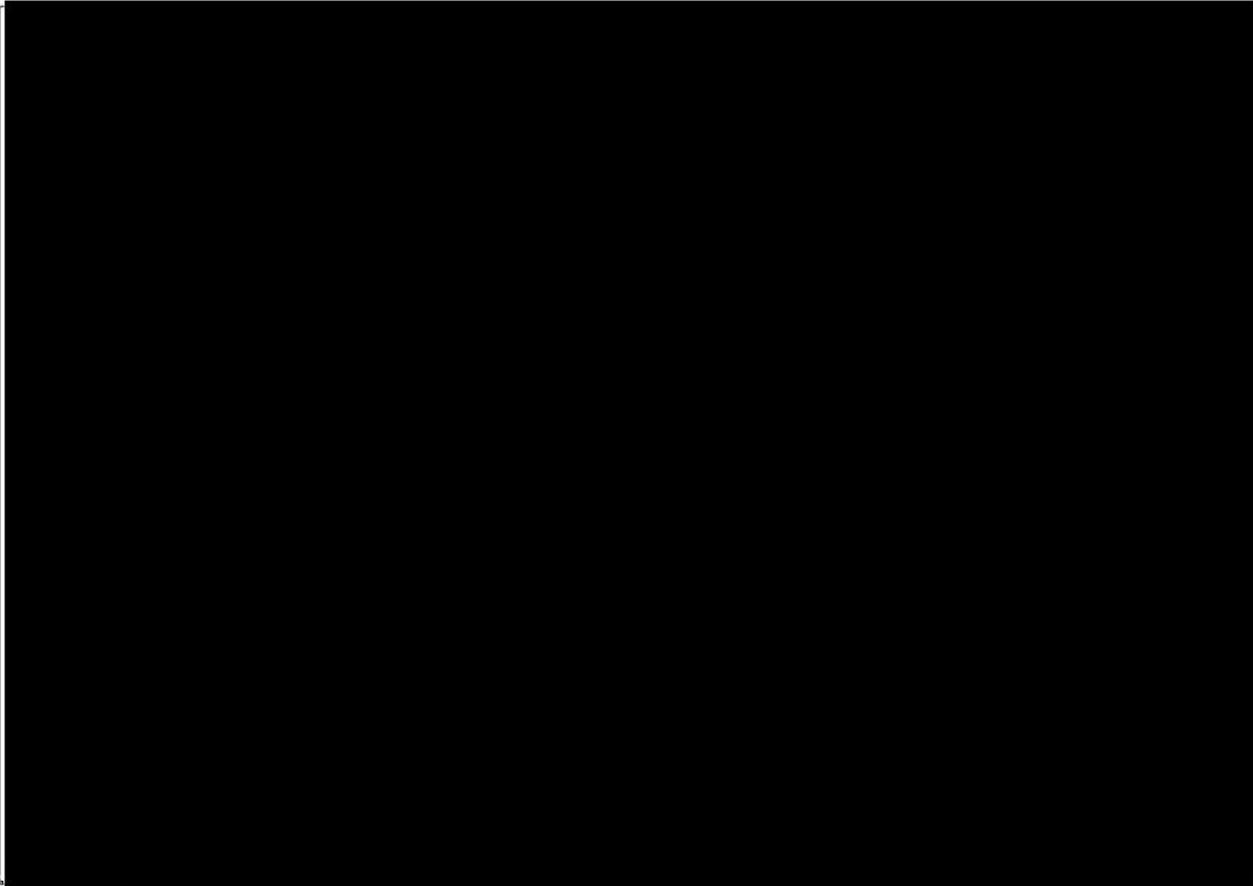
- Photo
- Drawings
- Sketch

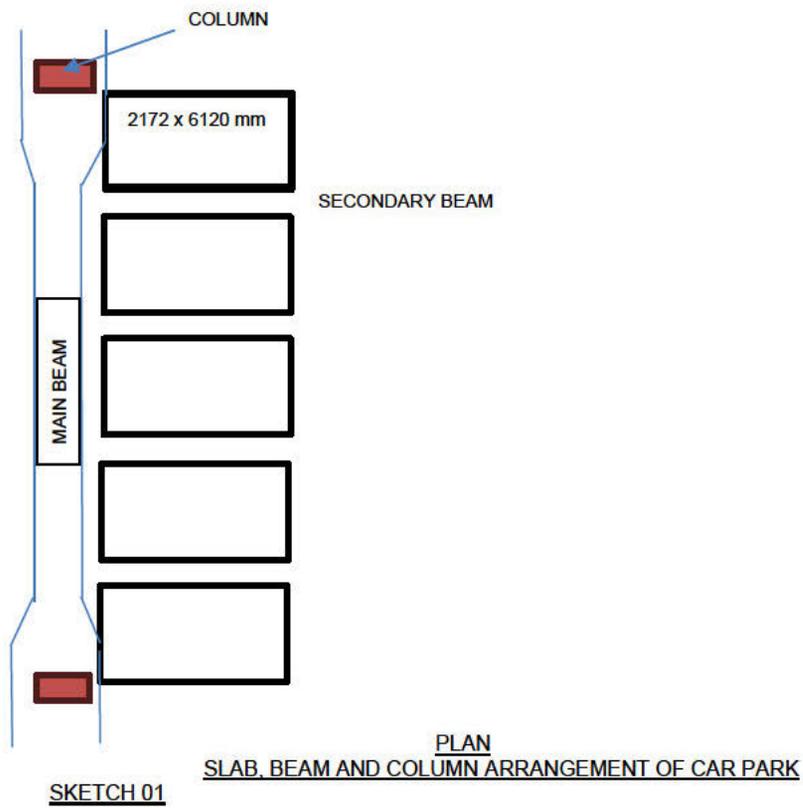


Bradford Interchange Bus Station



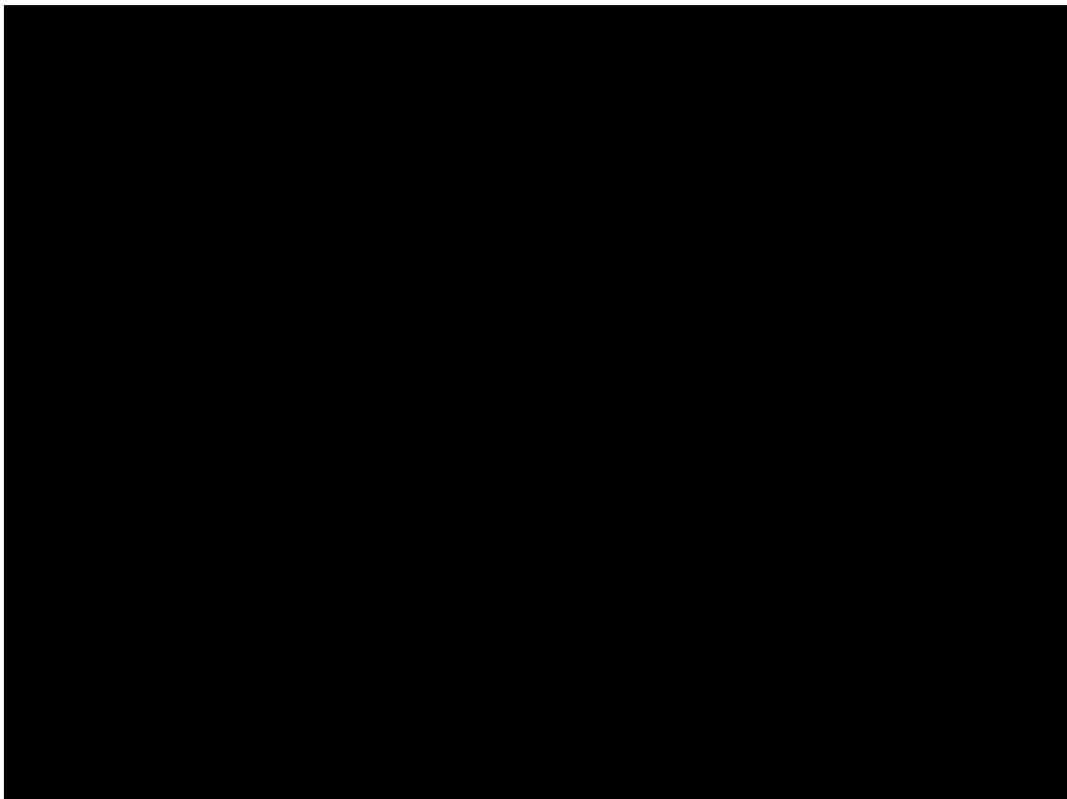
NCP Car park

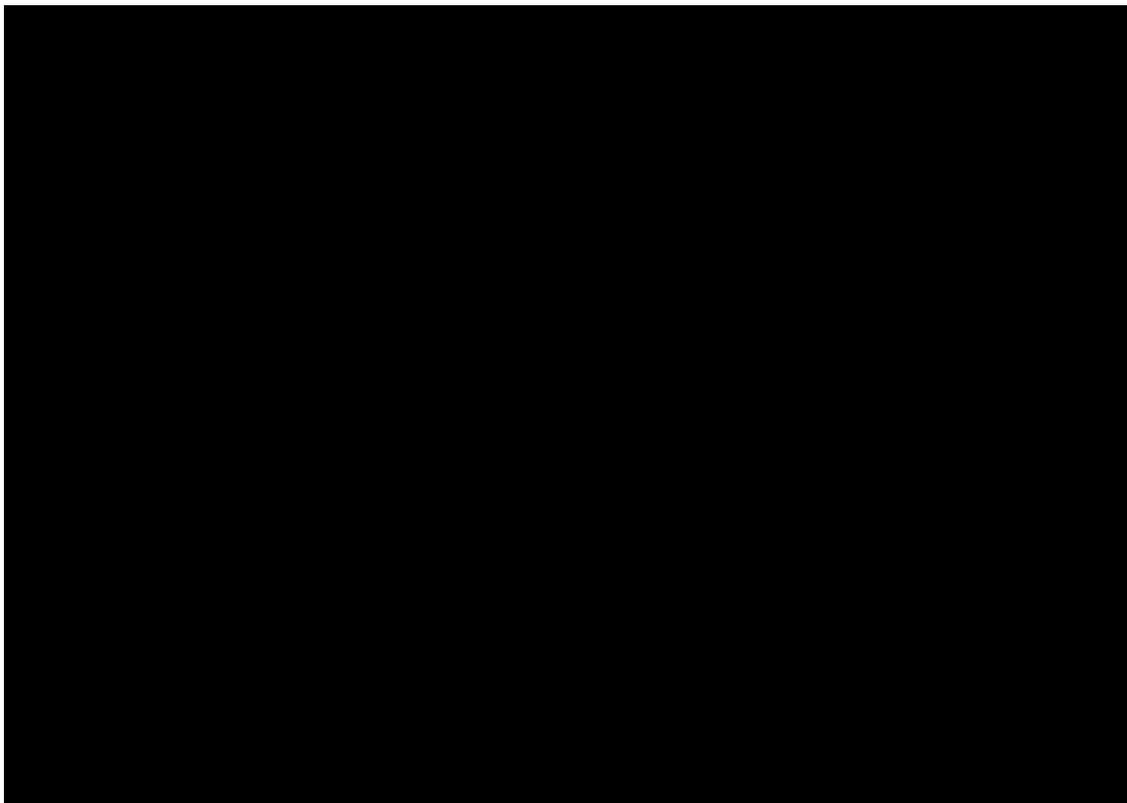
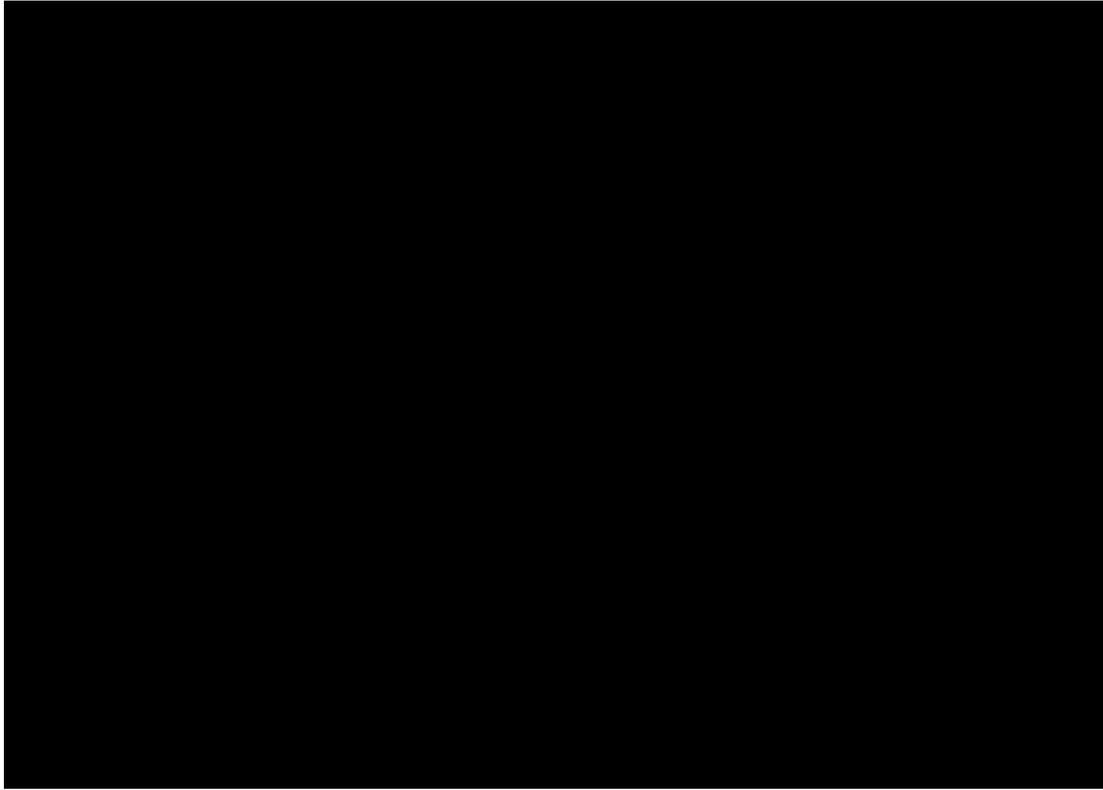


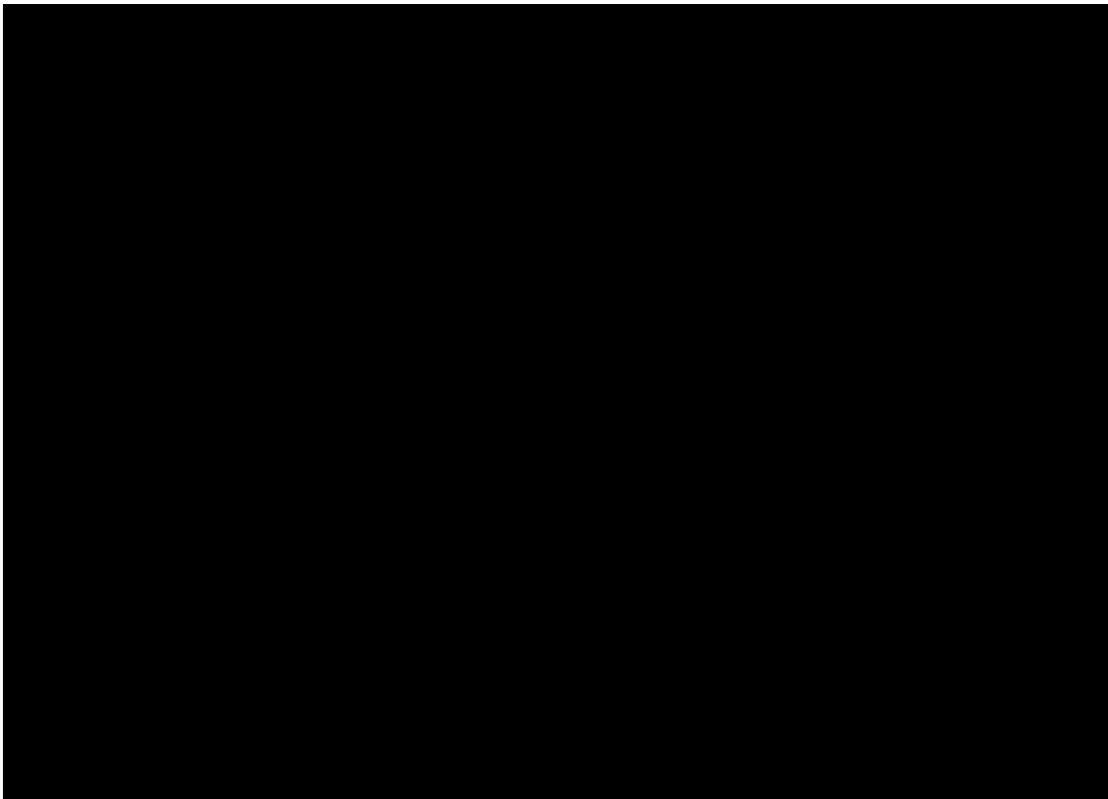
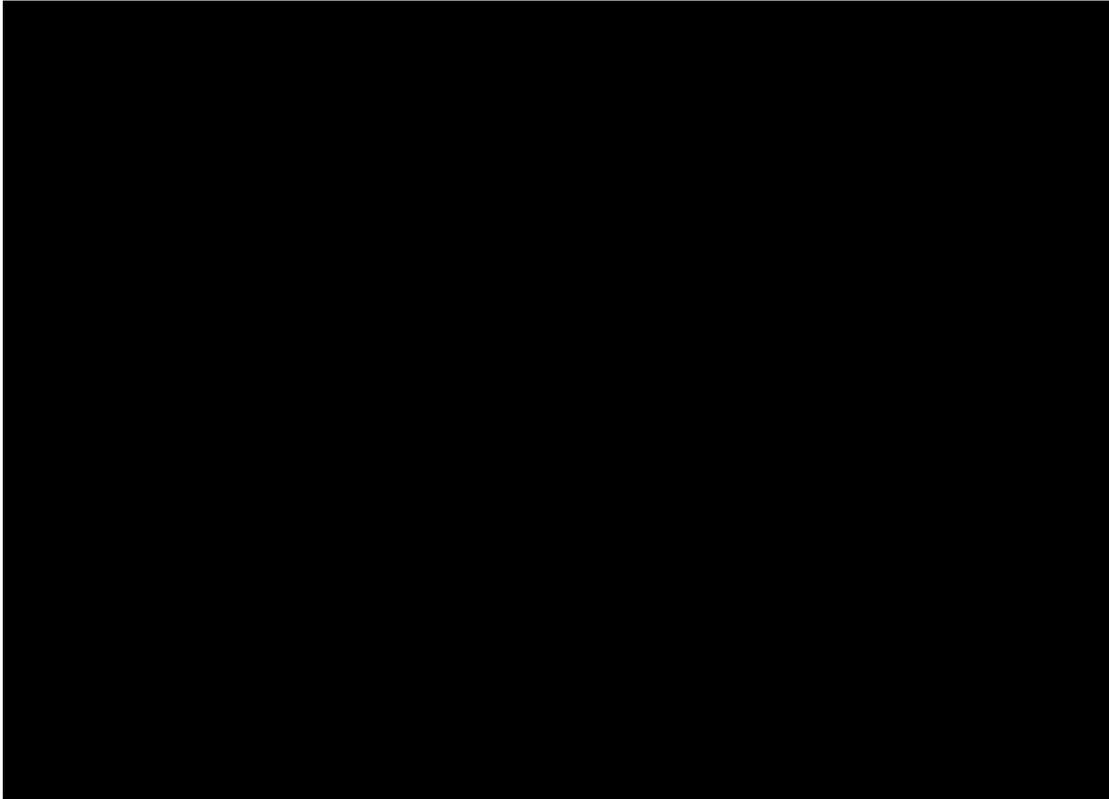


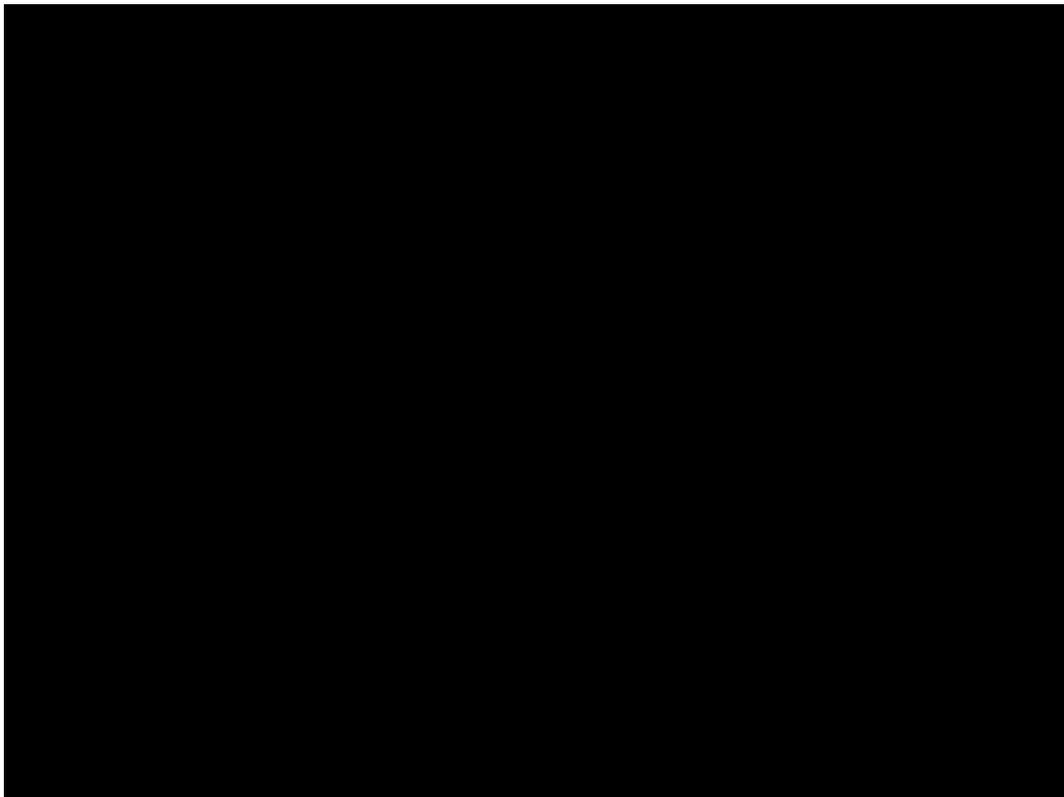
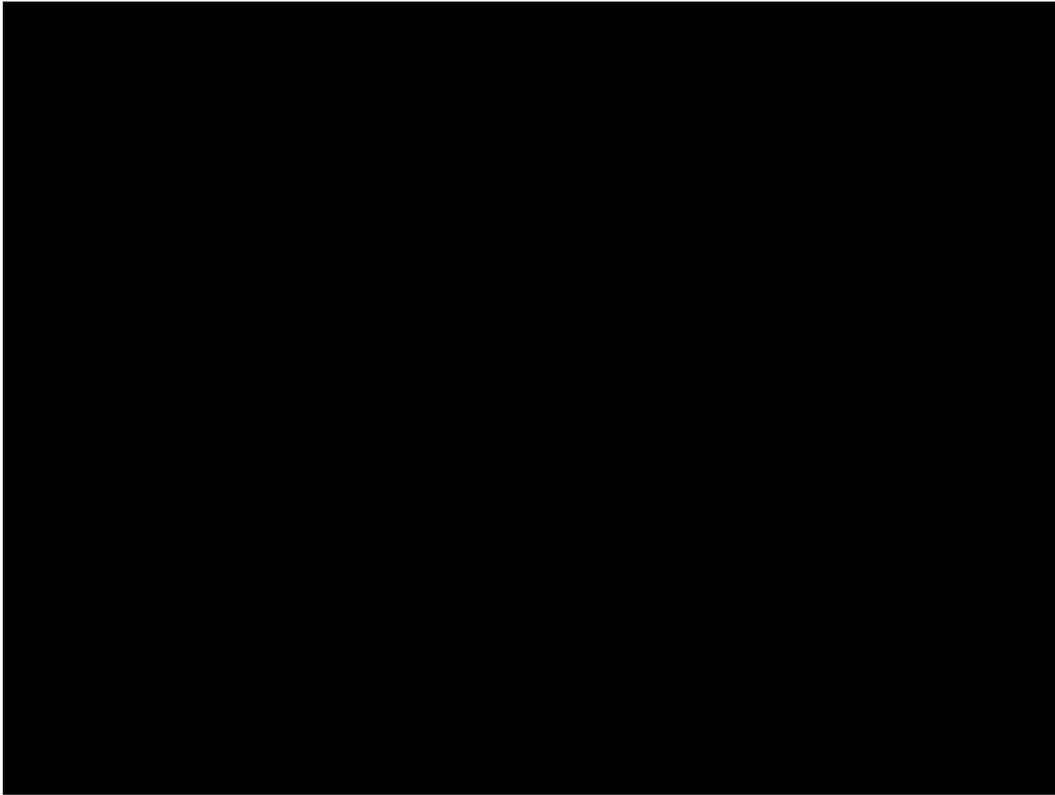
Appendix B

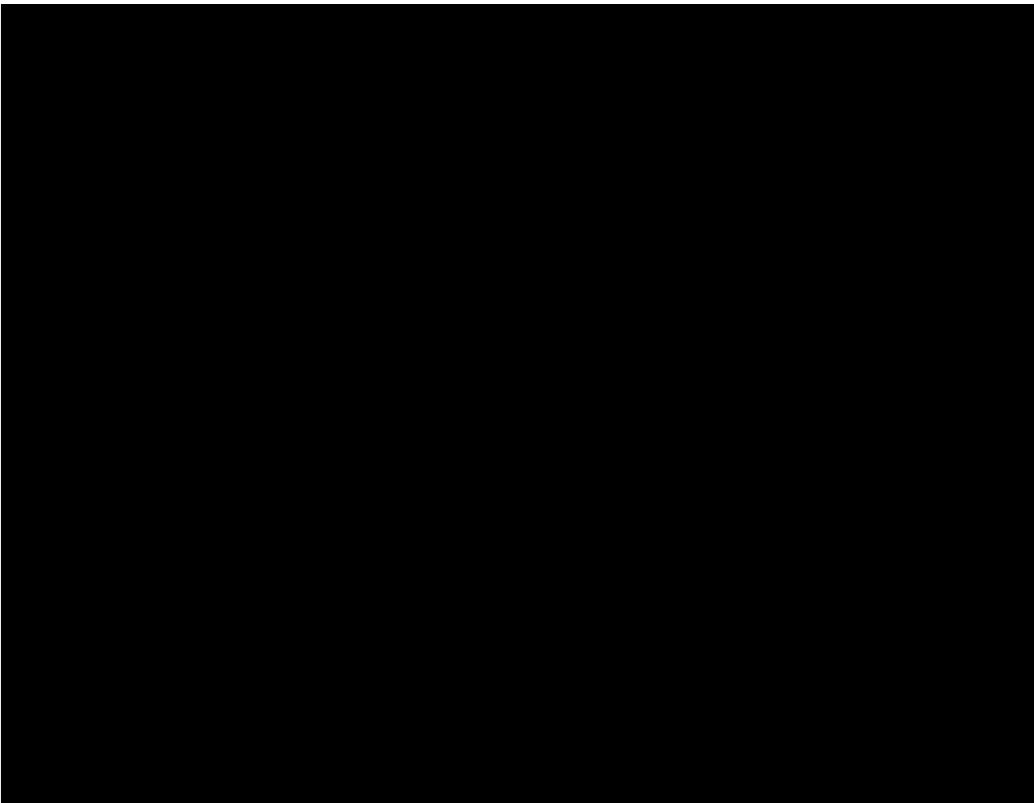
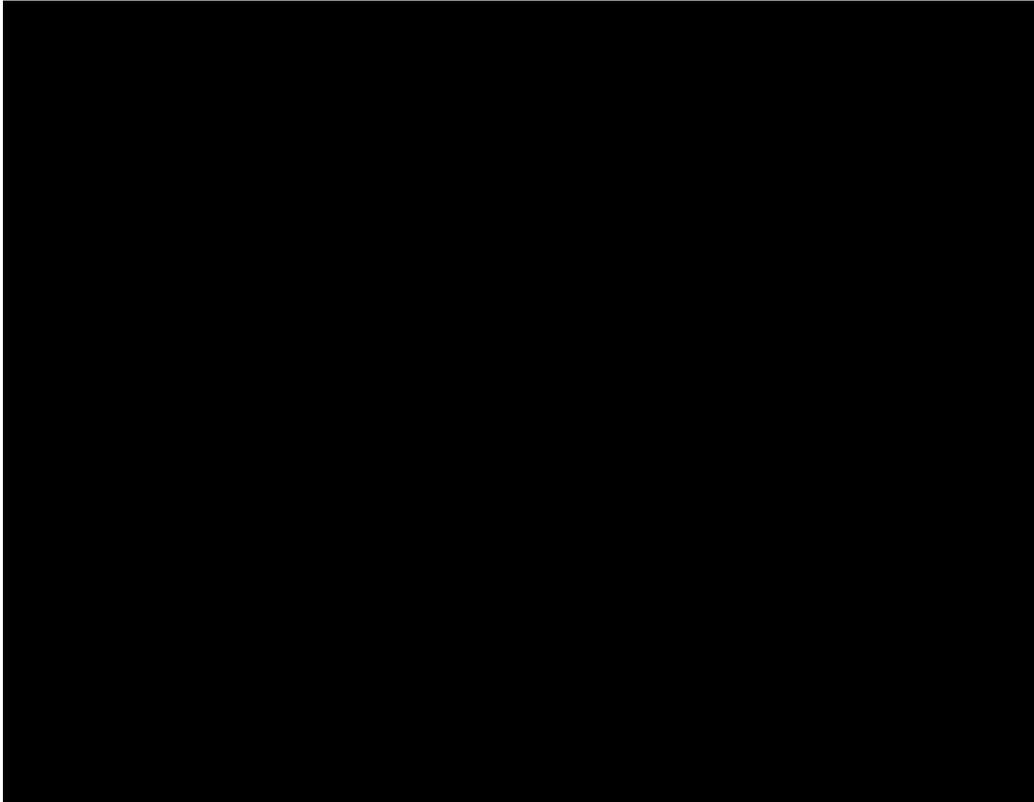
Photos

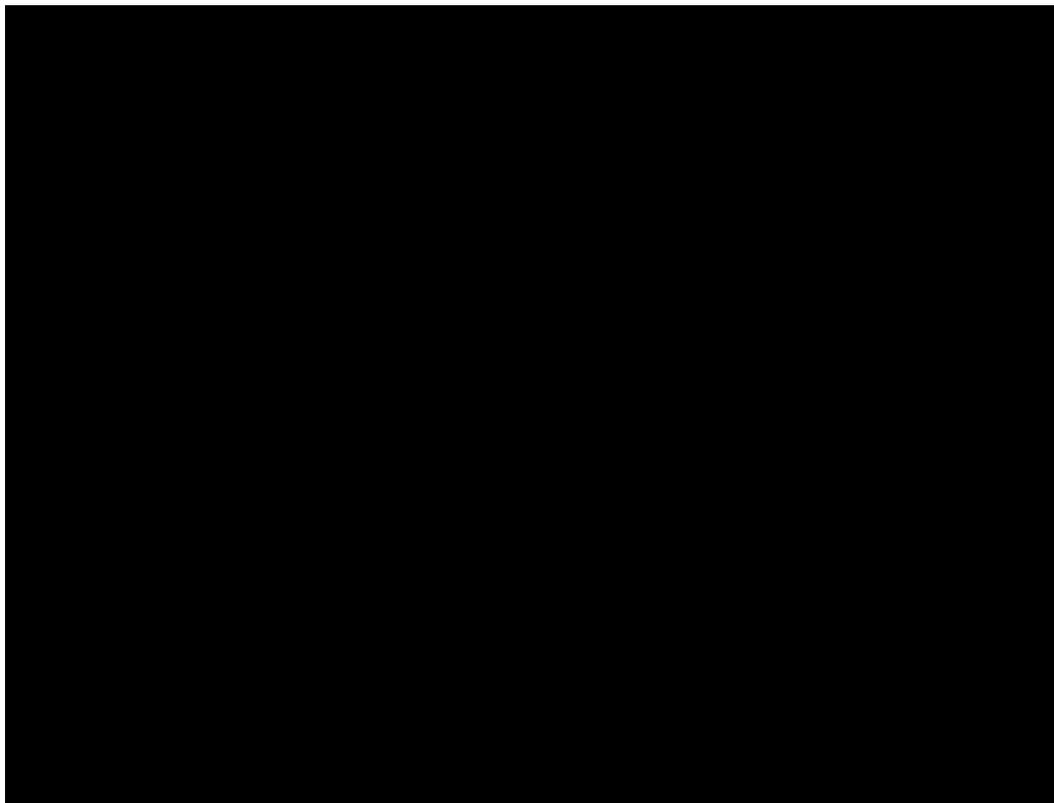
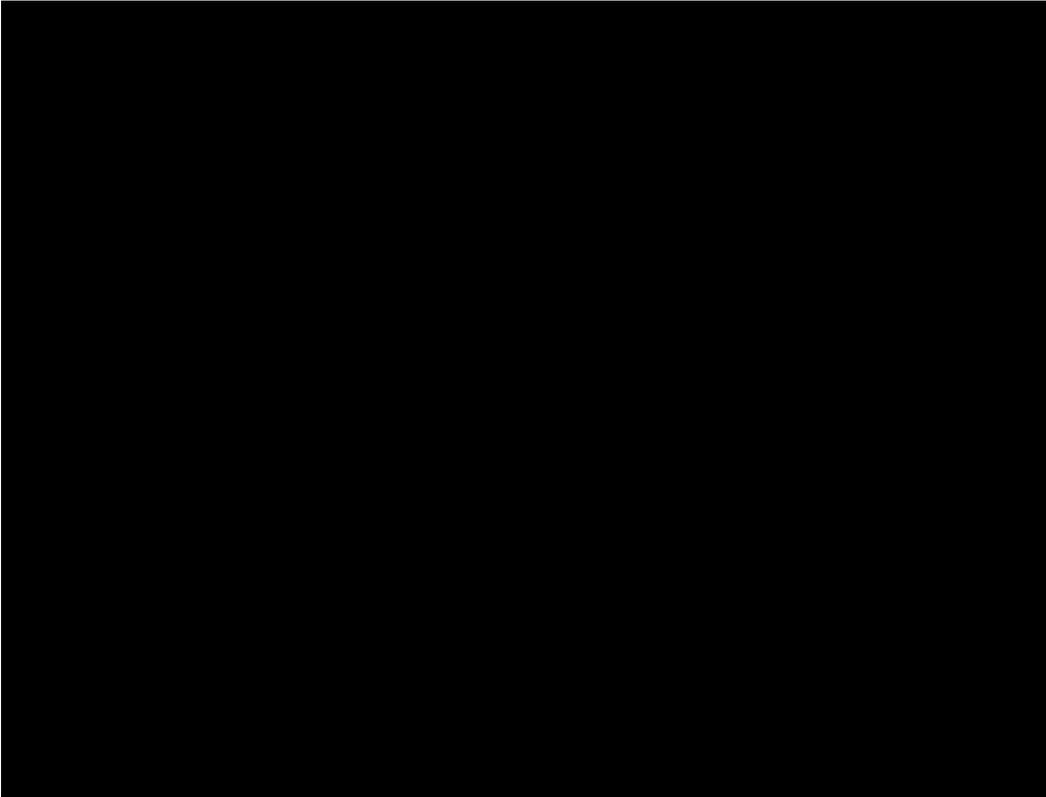


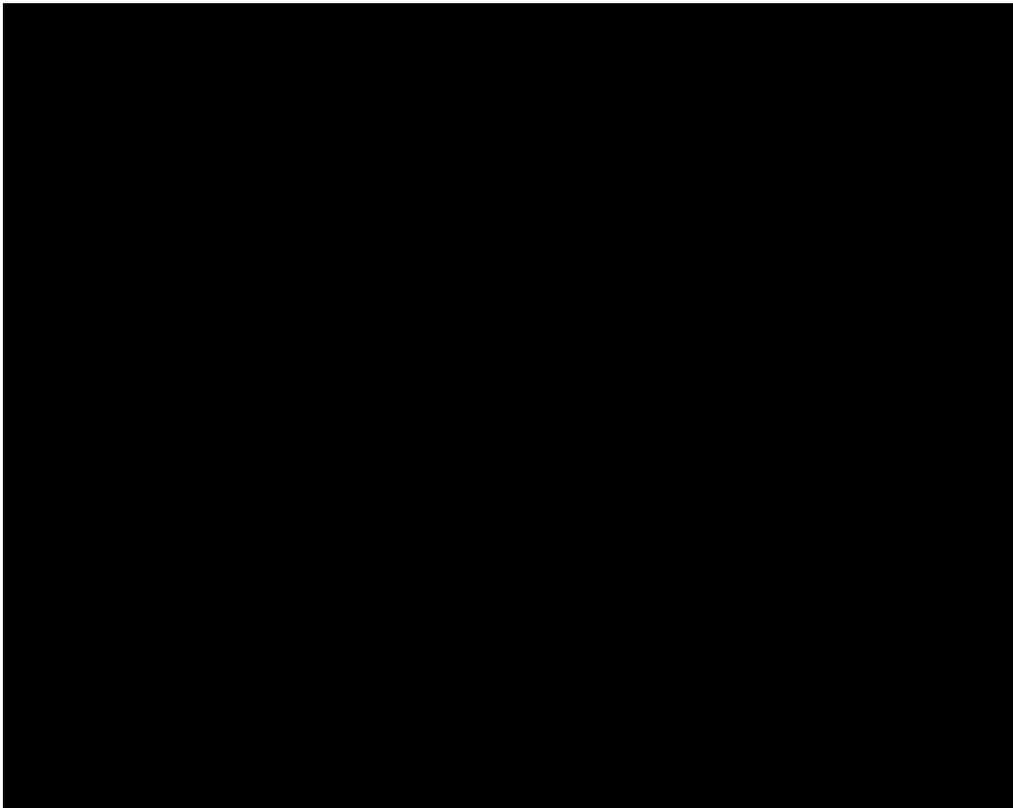
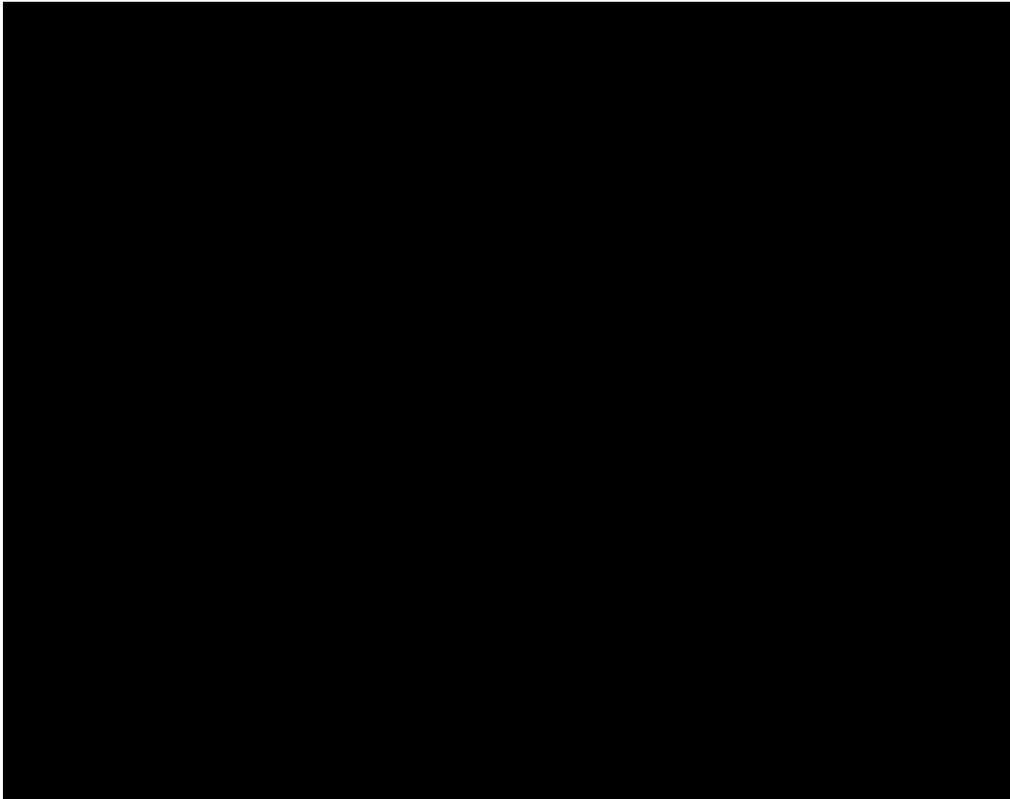


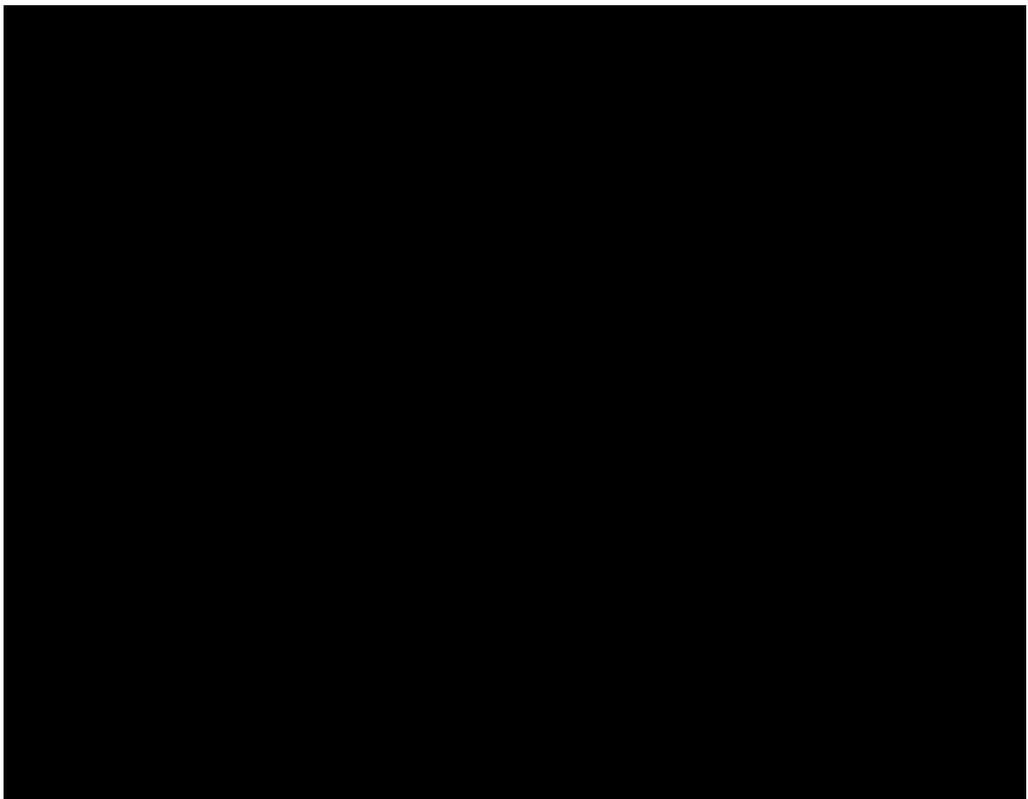
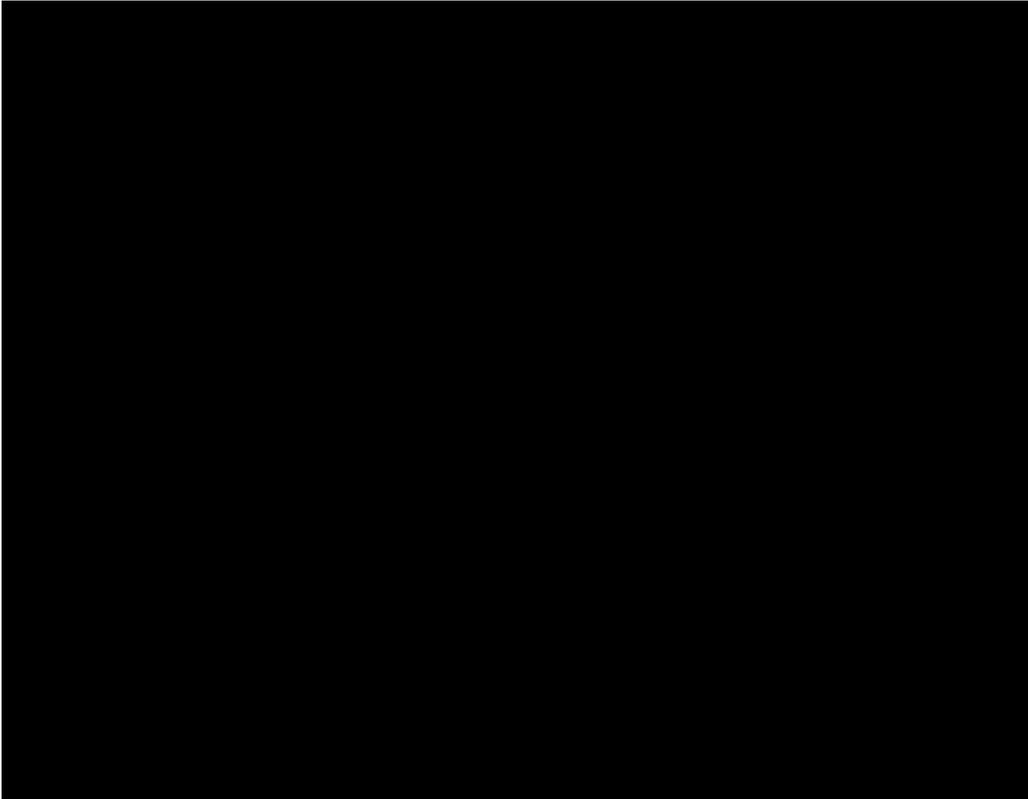


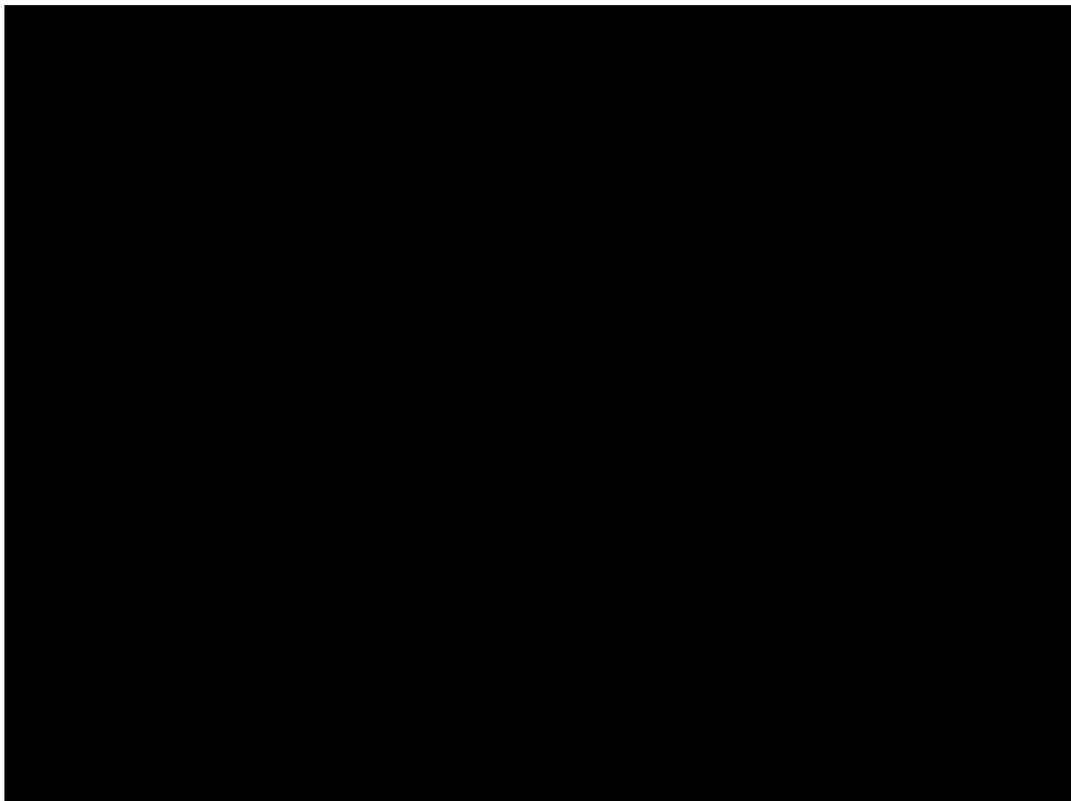
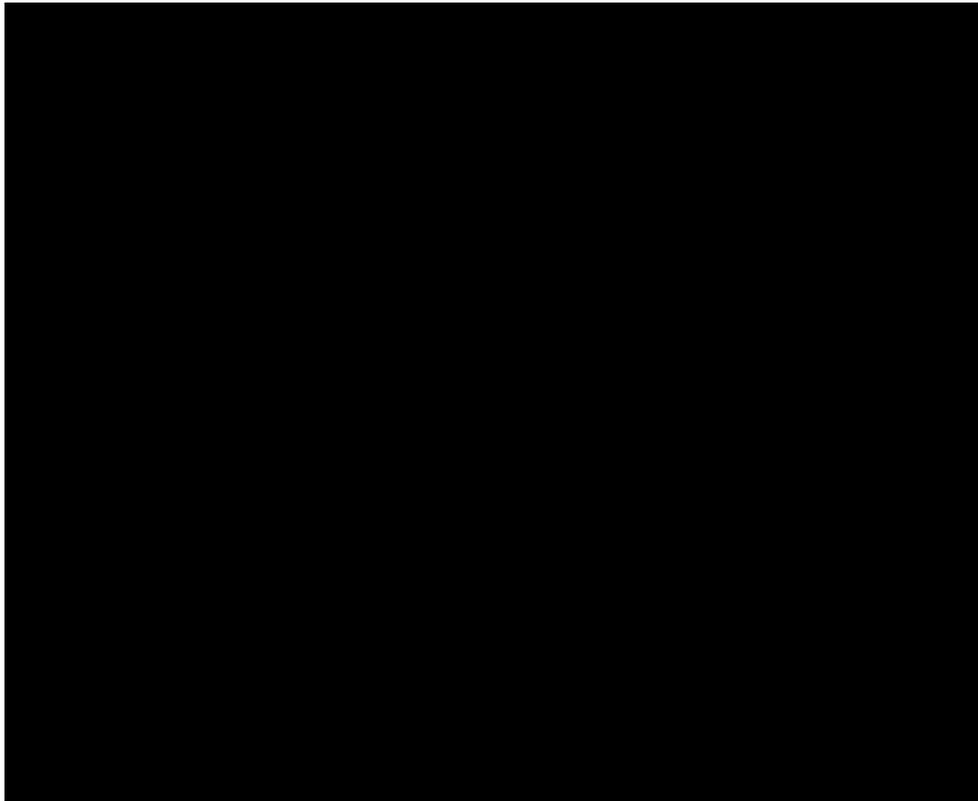


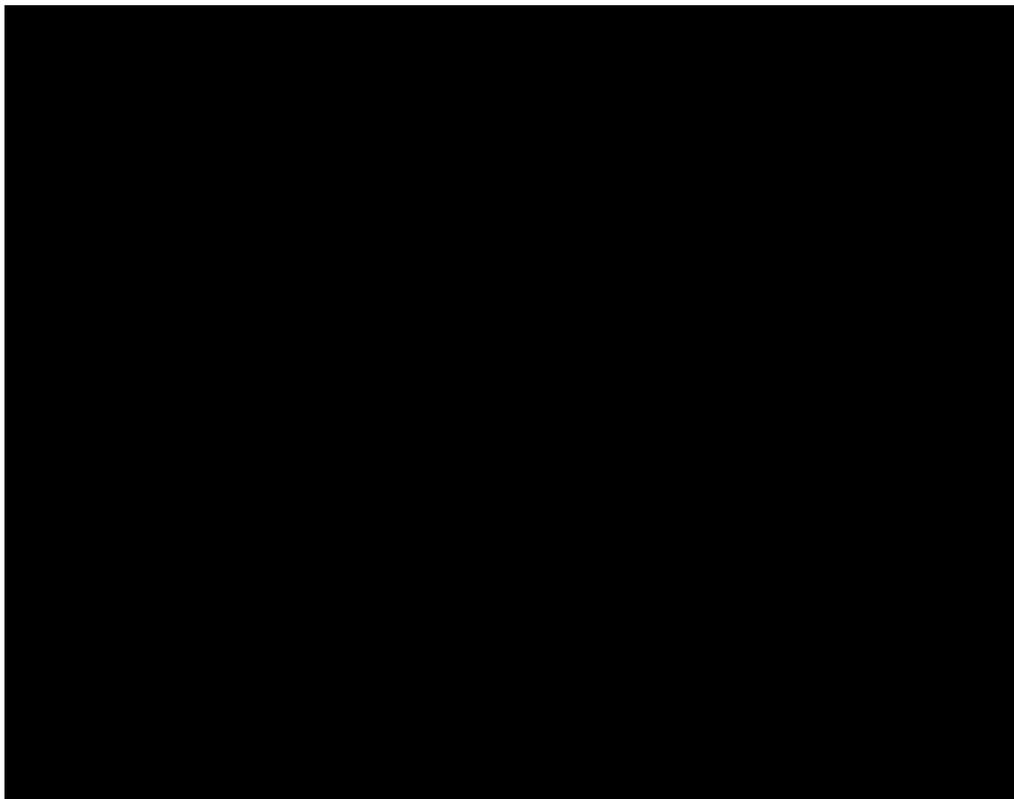
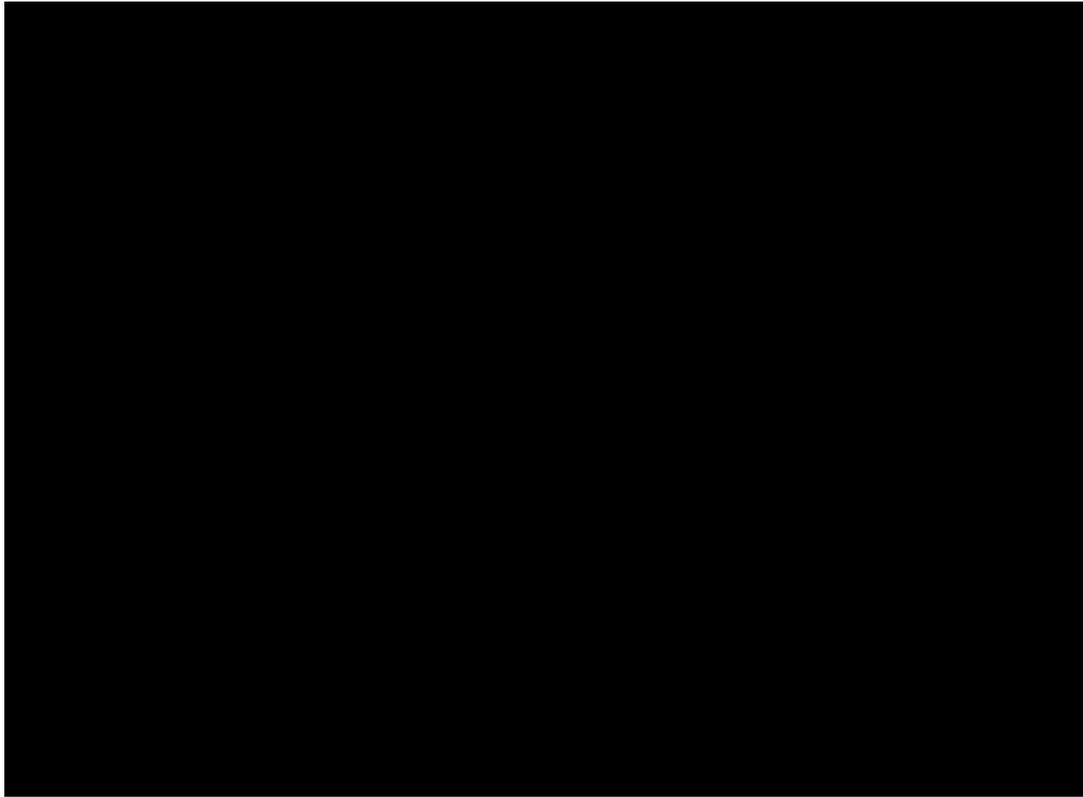


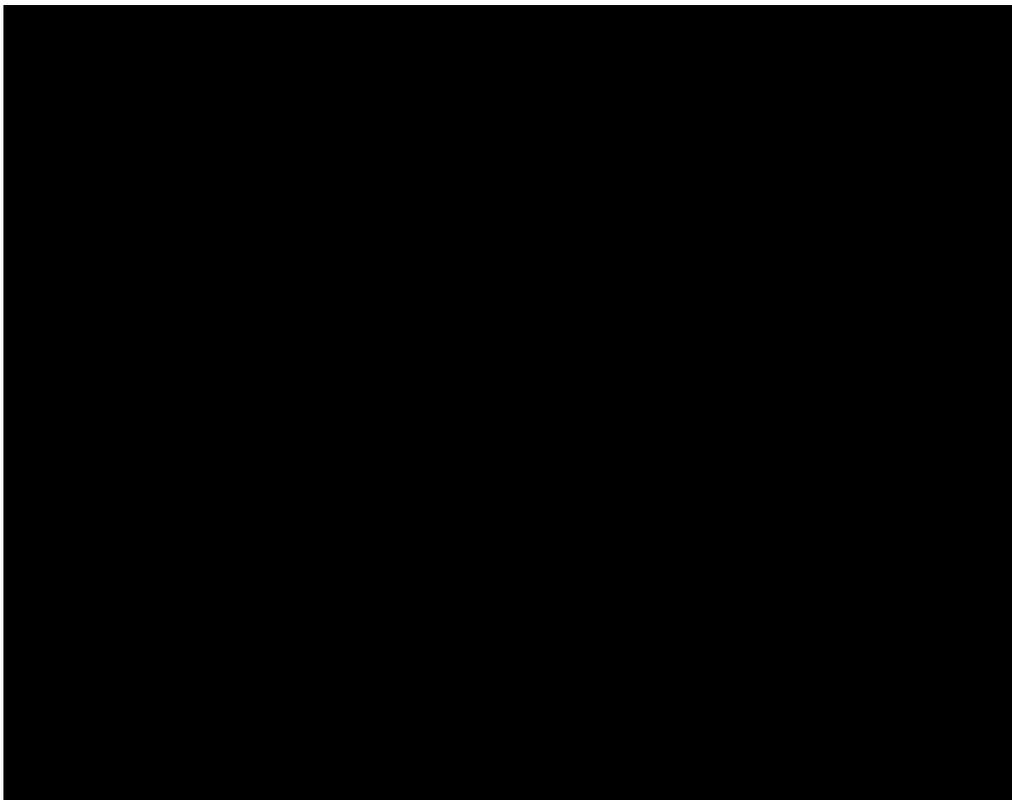
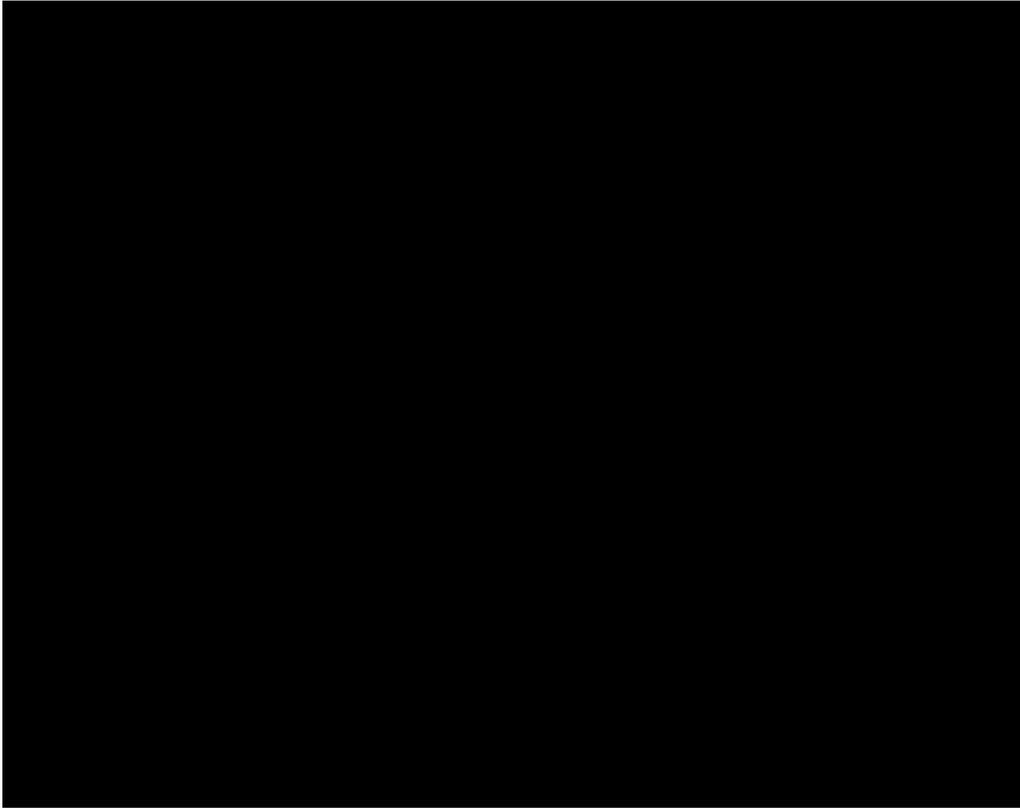


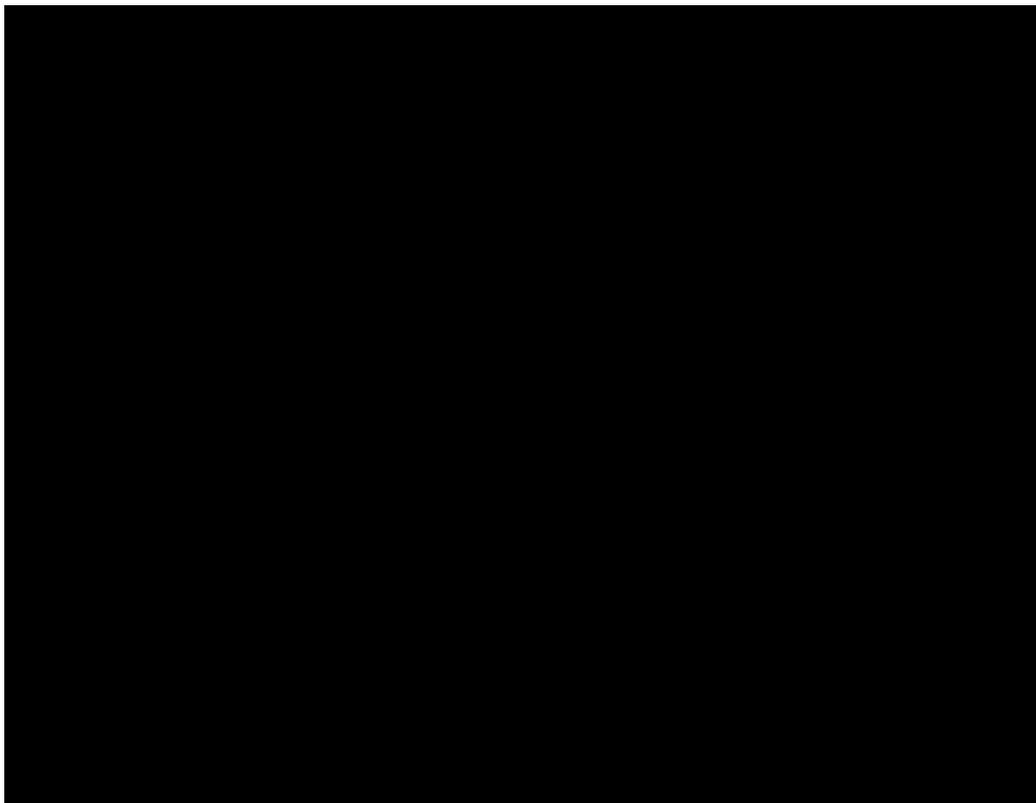
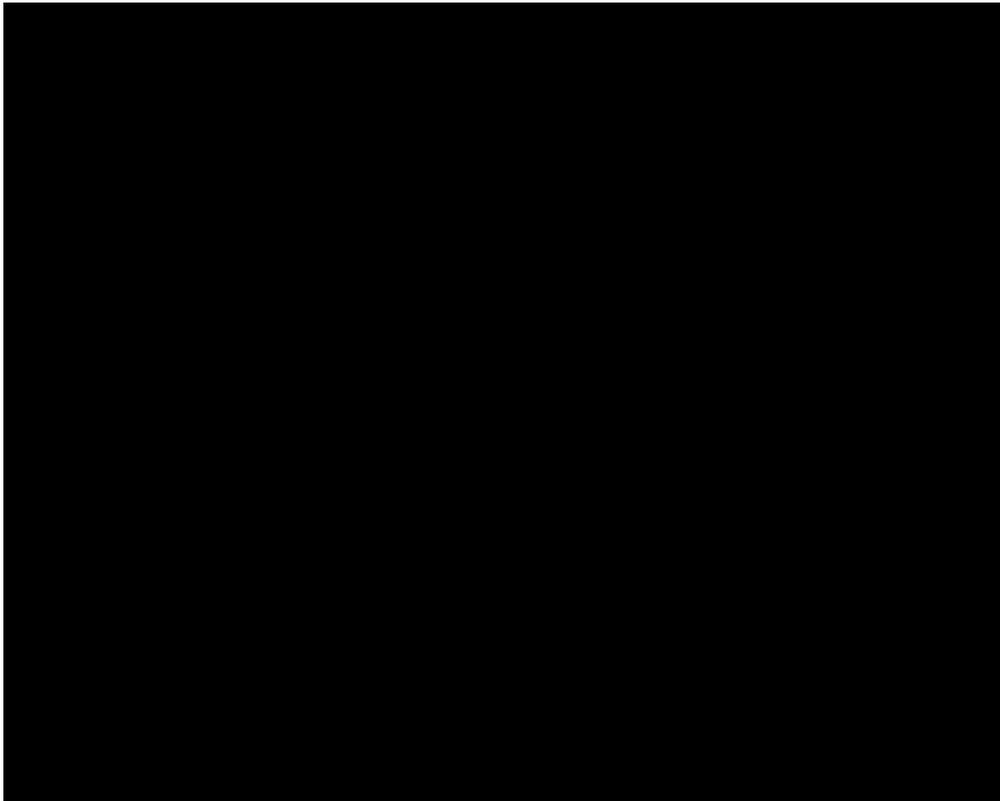


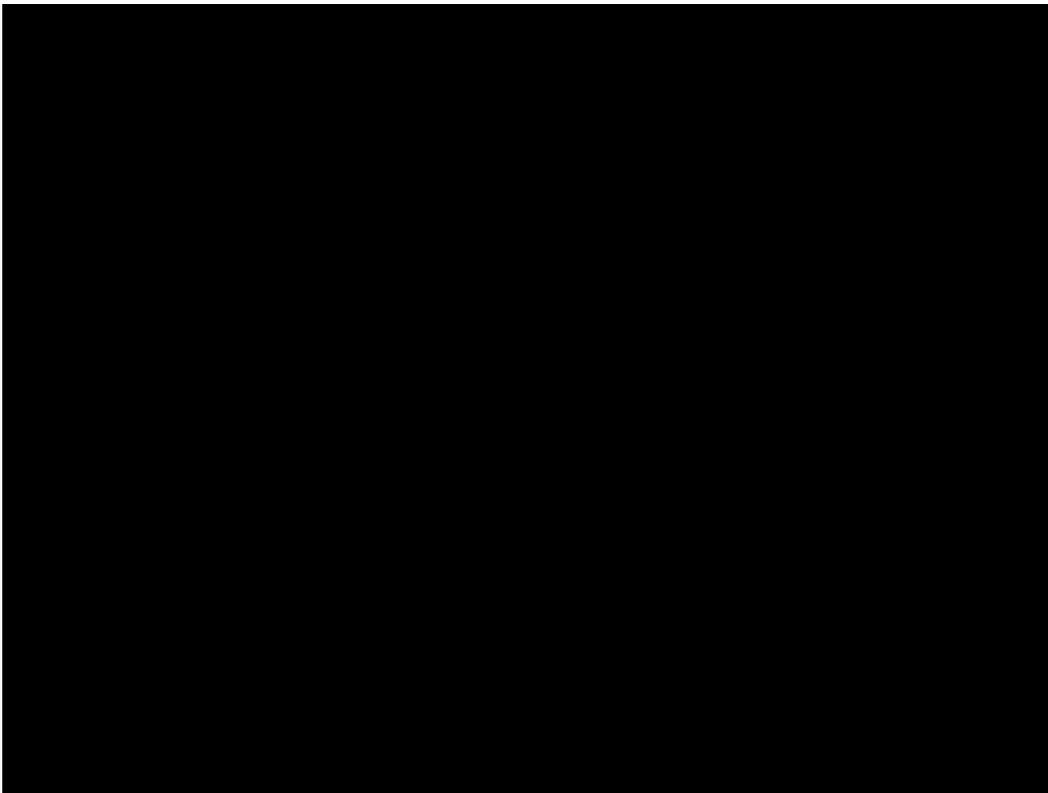
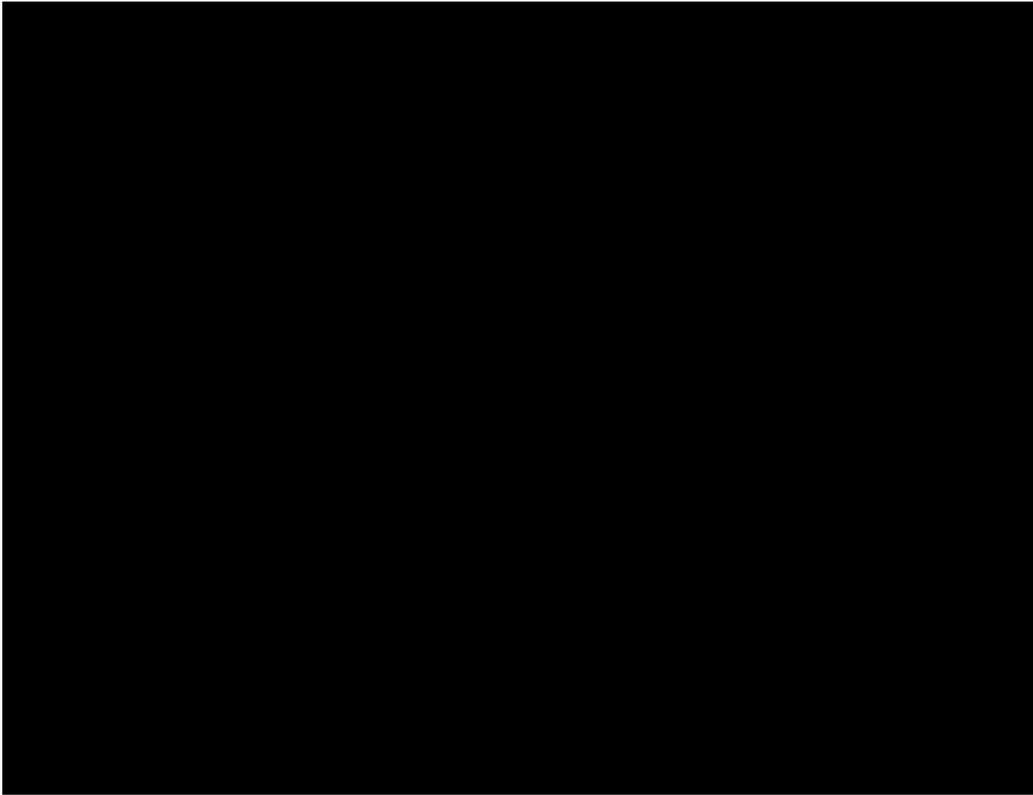


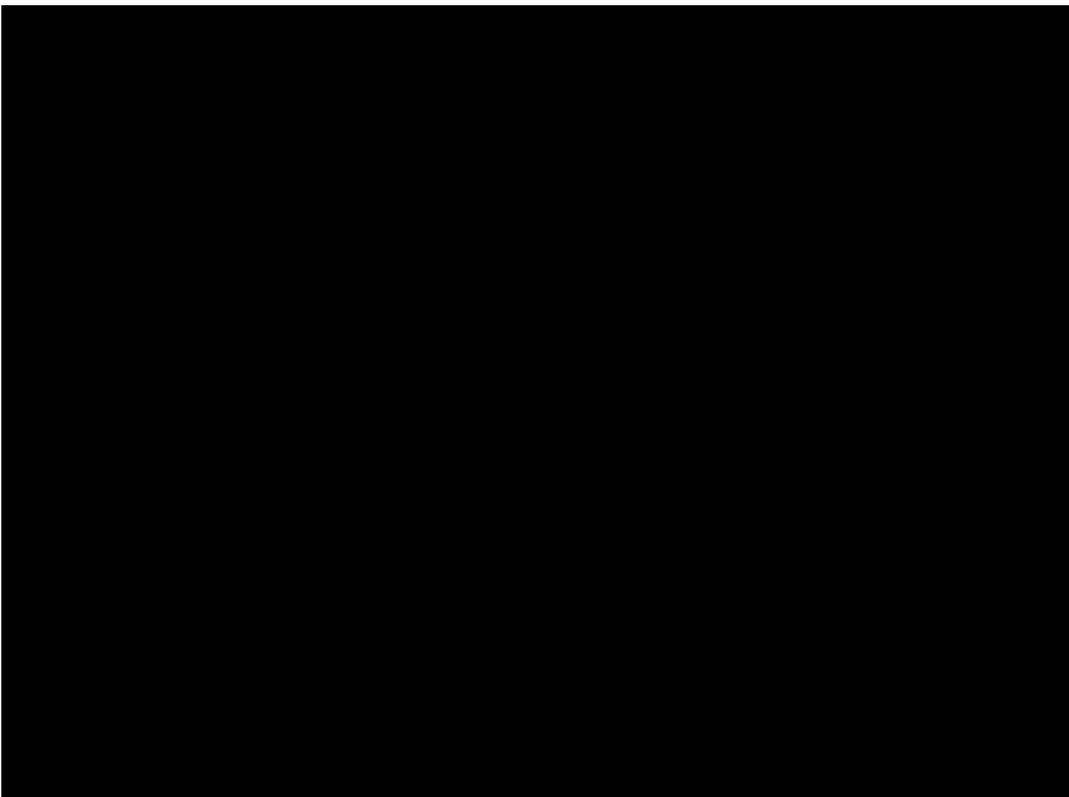
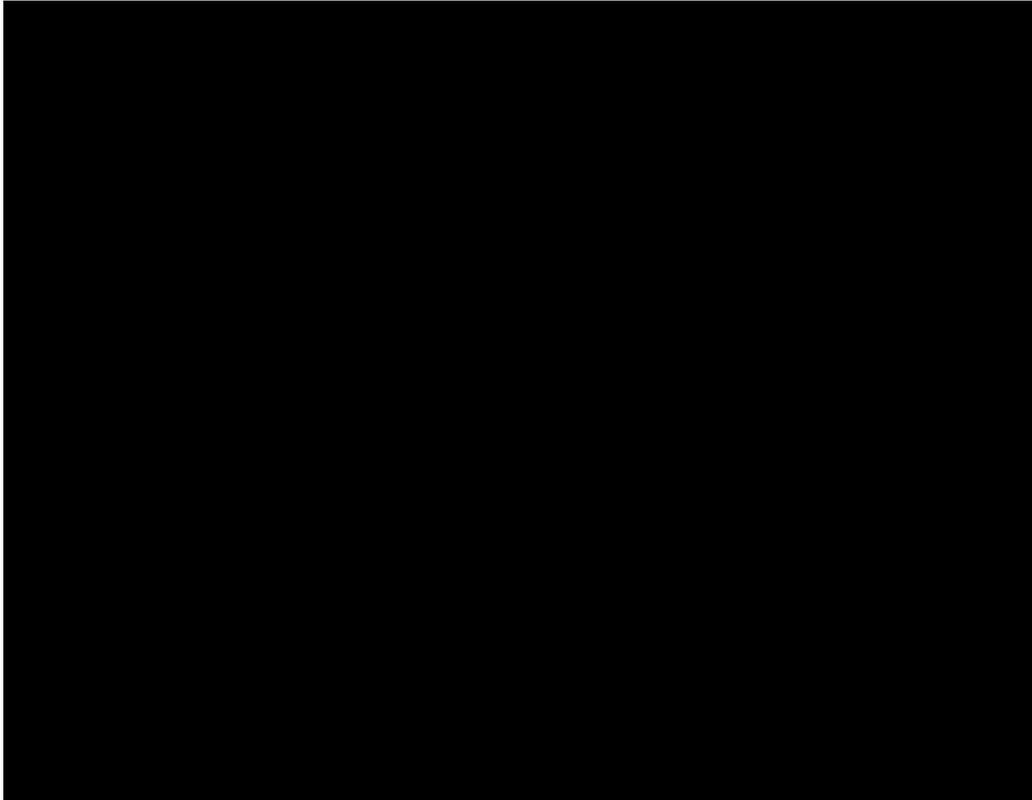












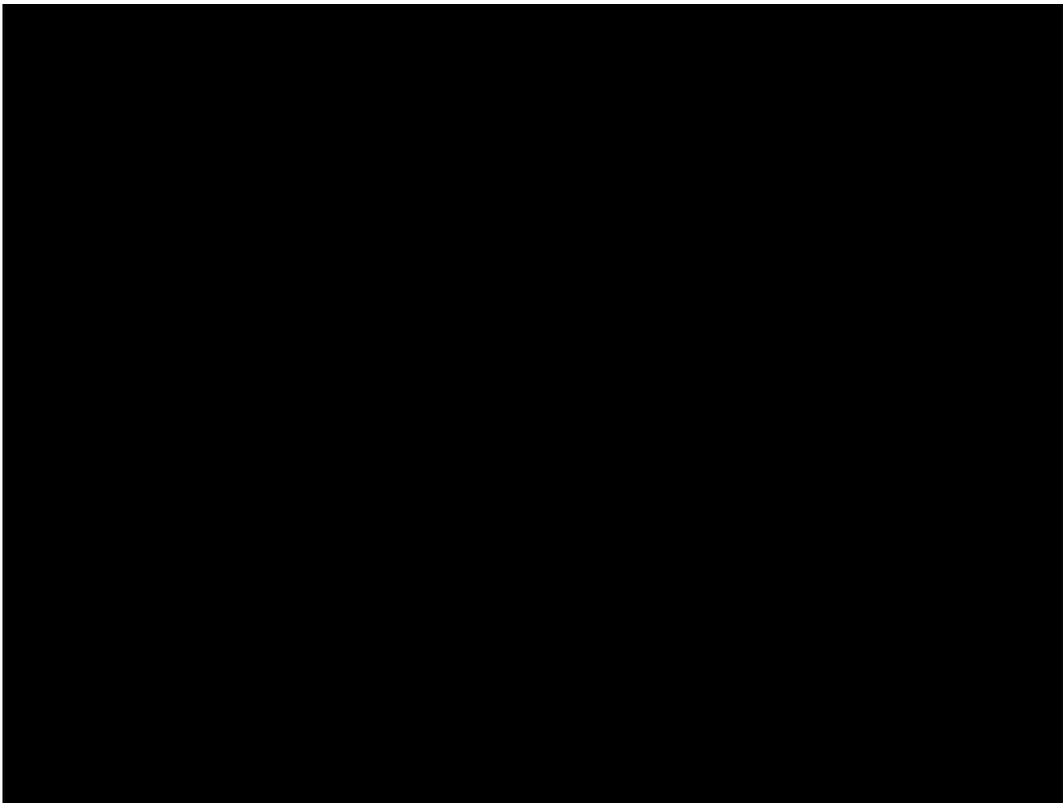
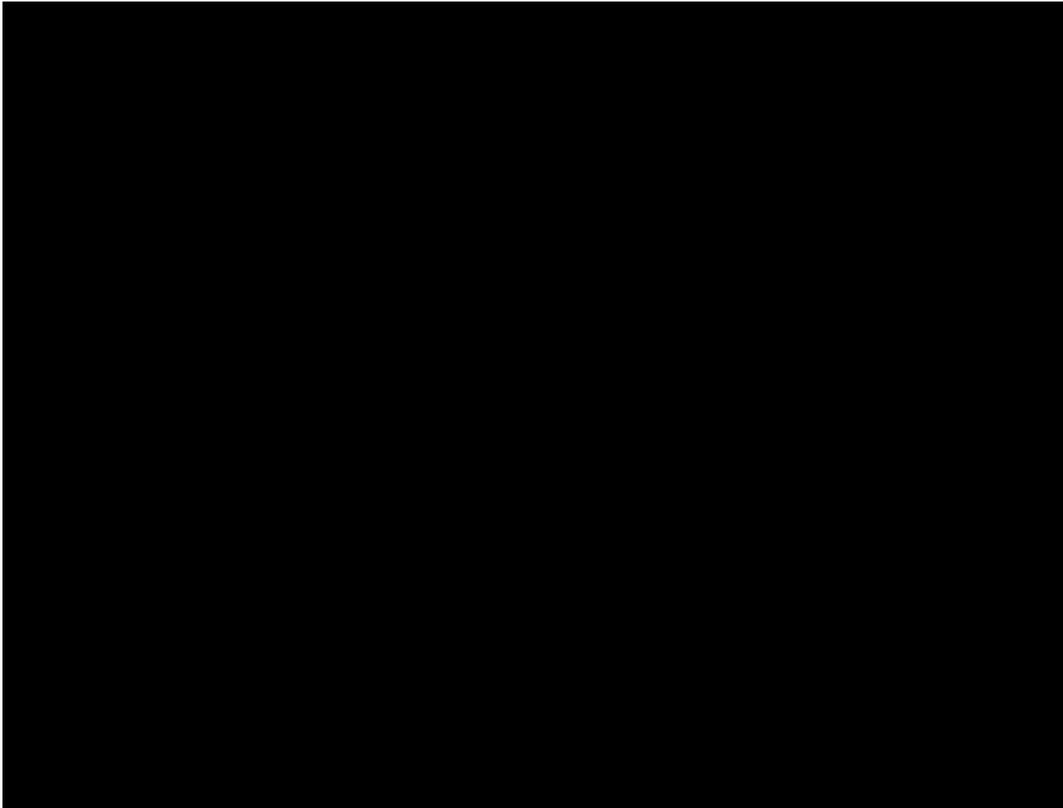
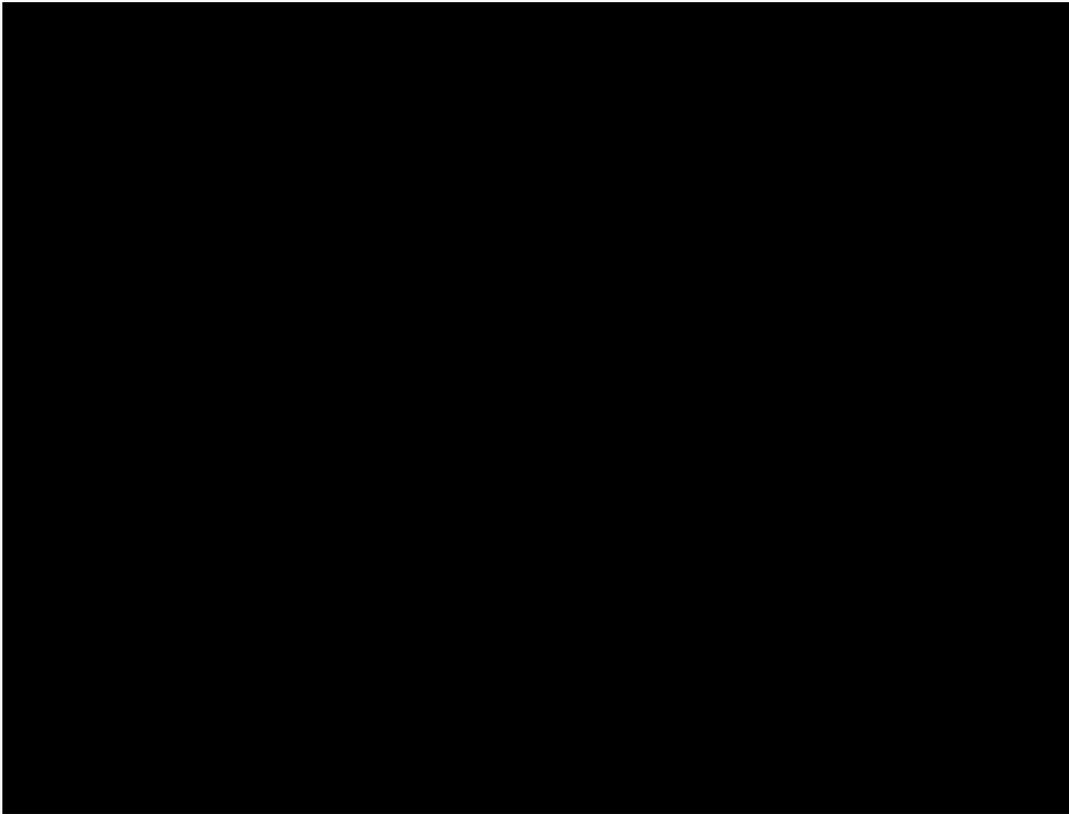
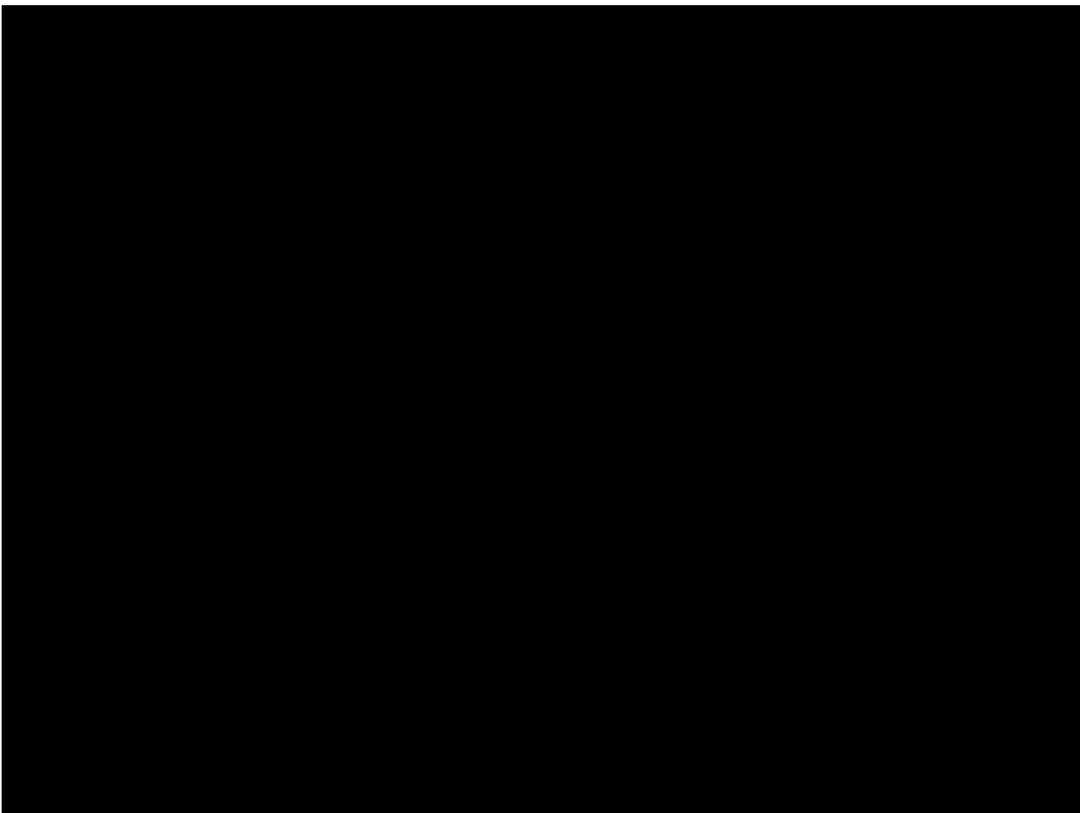
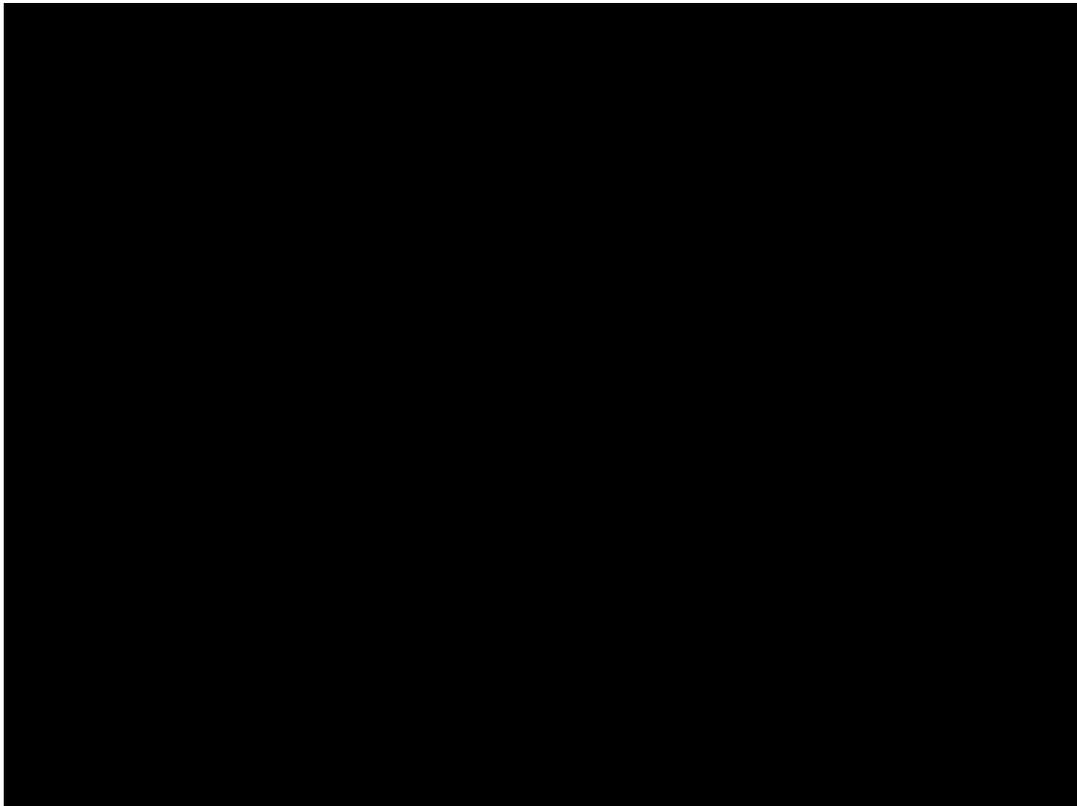
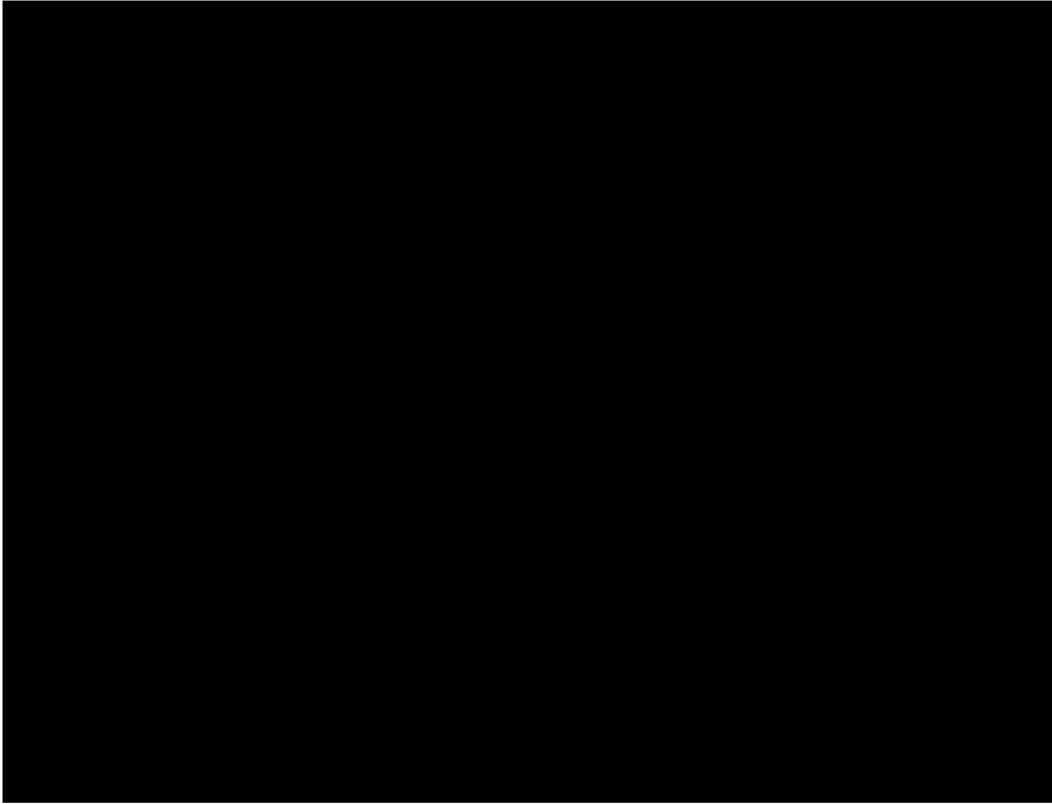


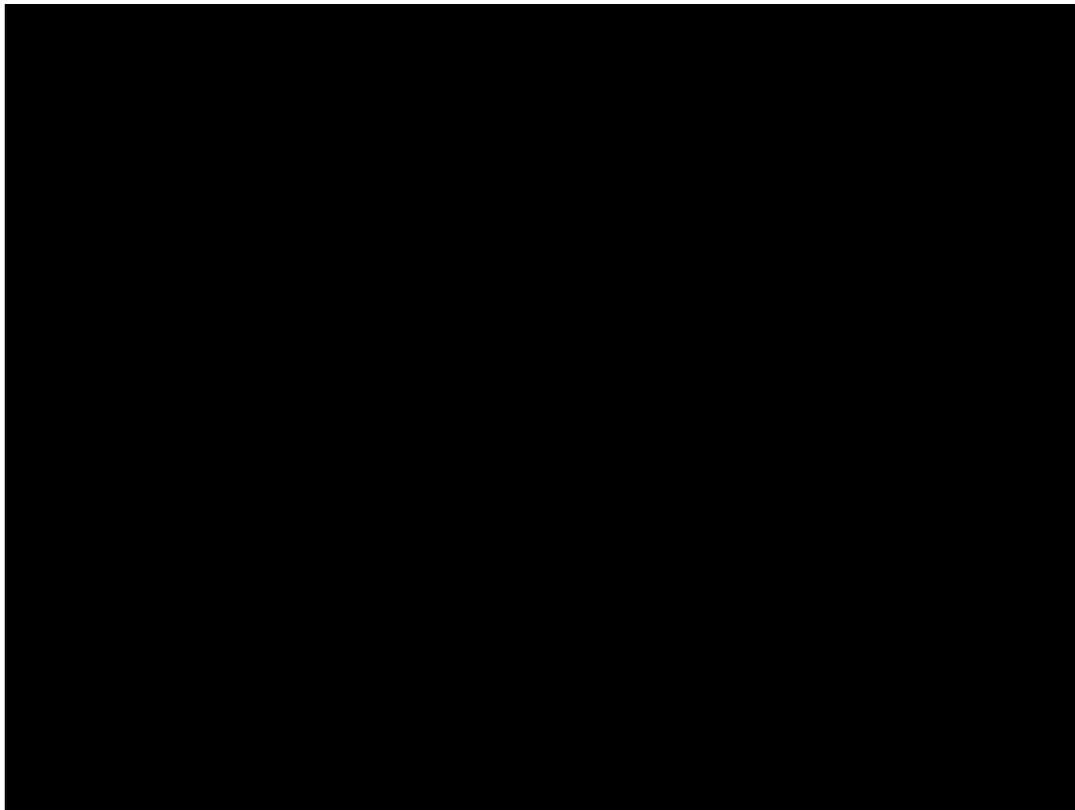
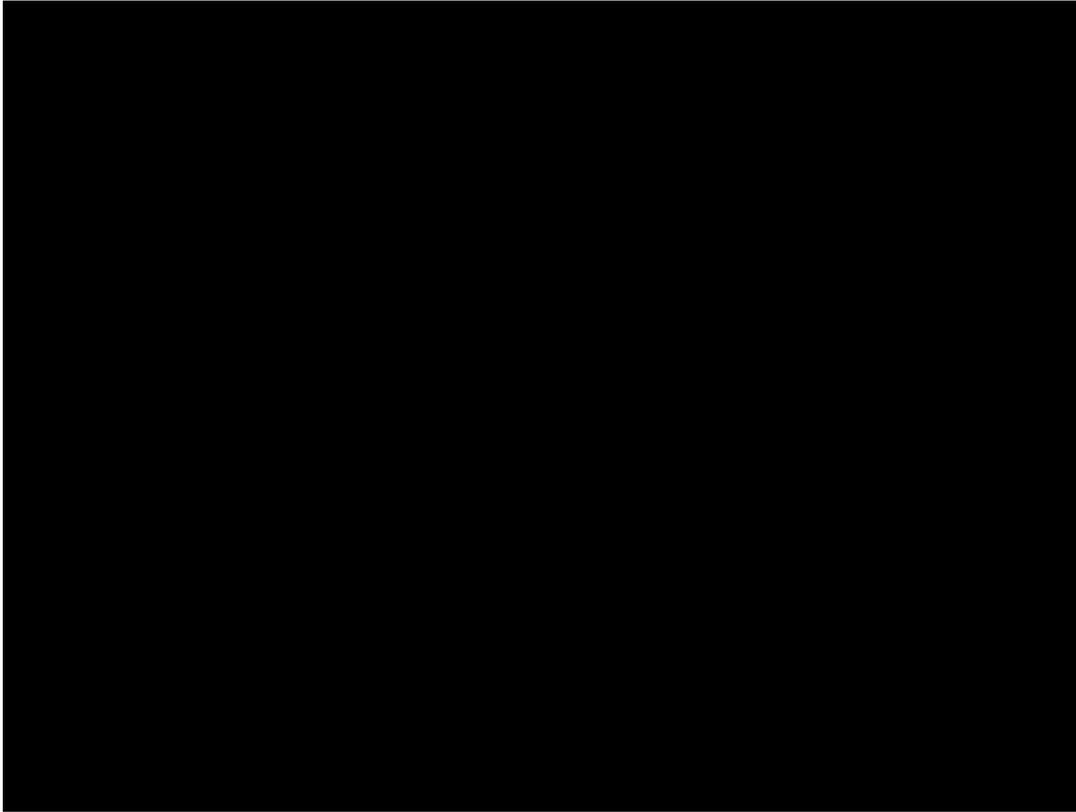


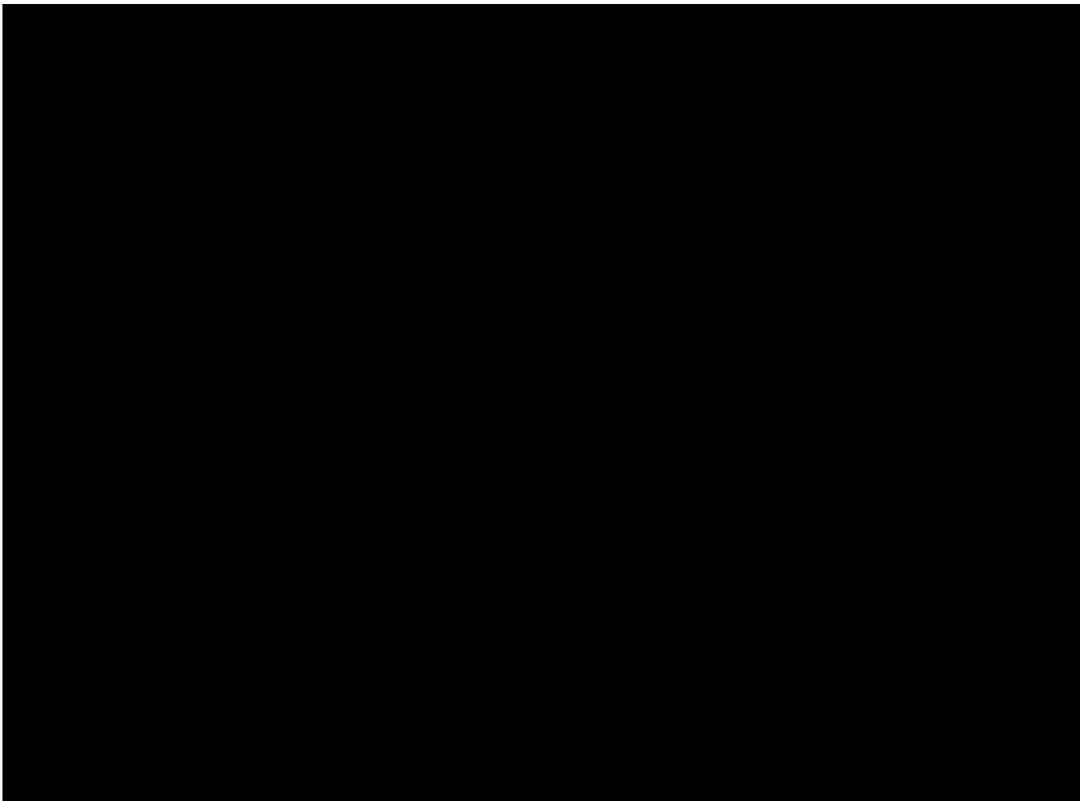
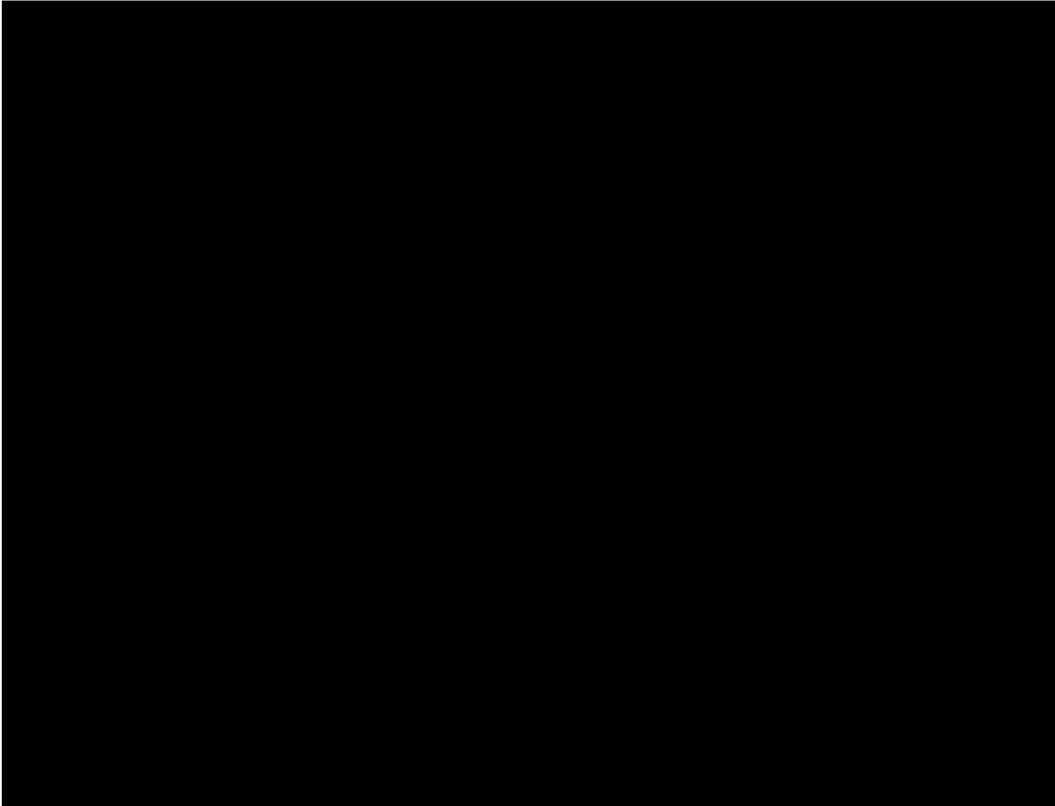
Photo 31 – Works area above damaged slab

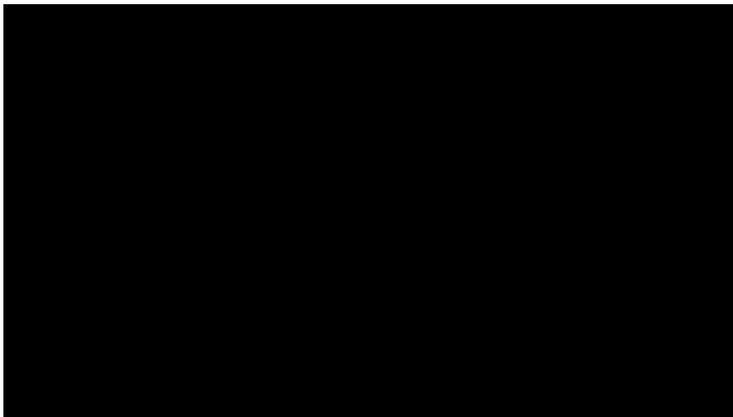
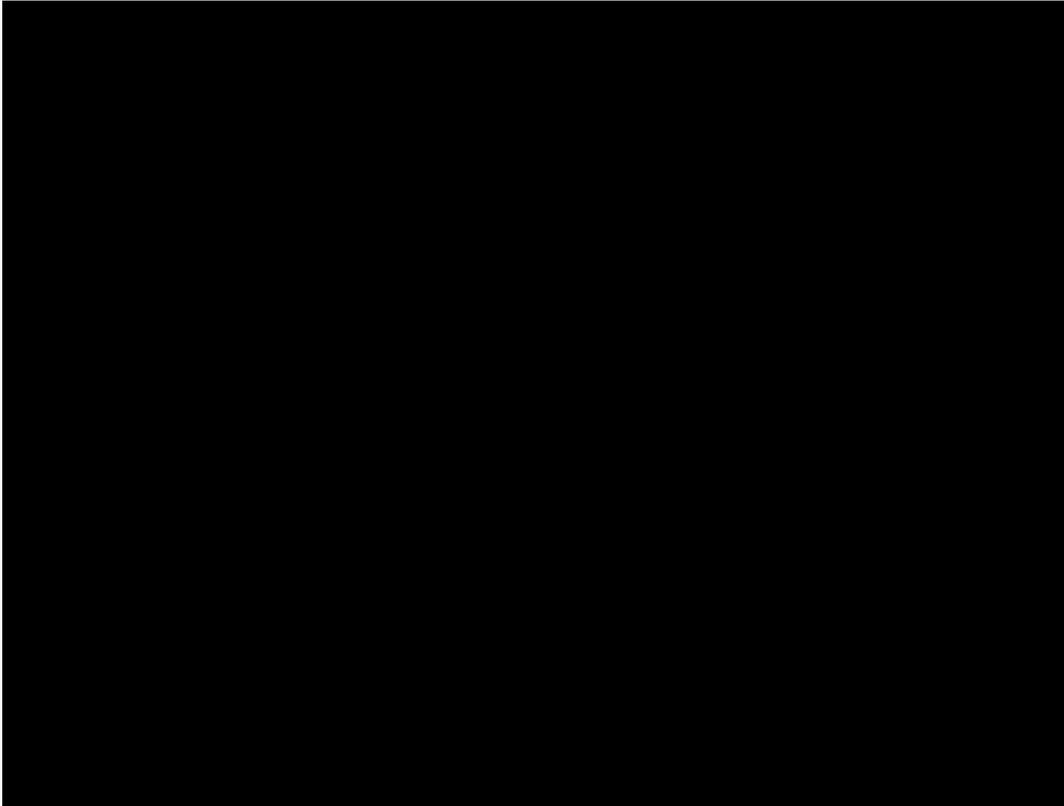


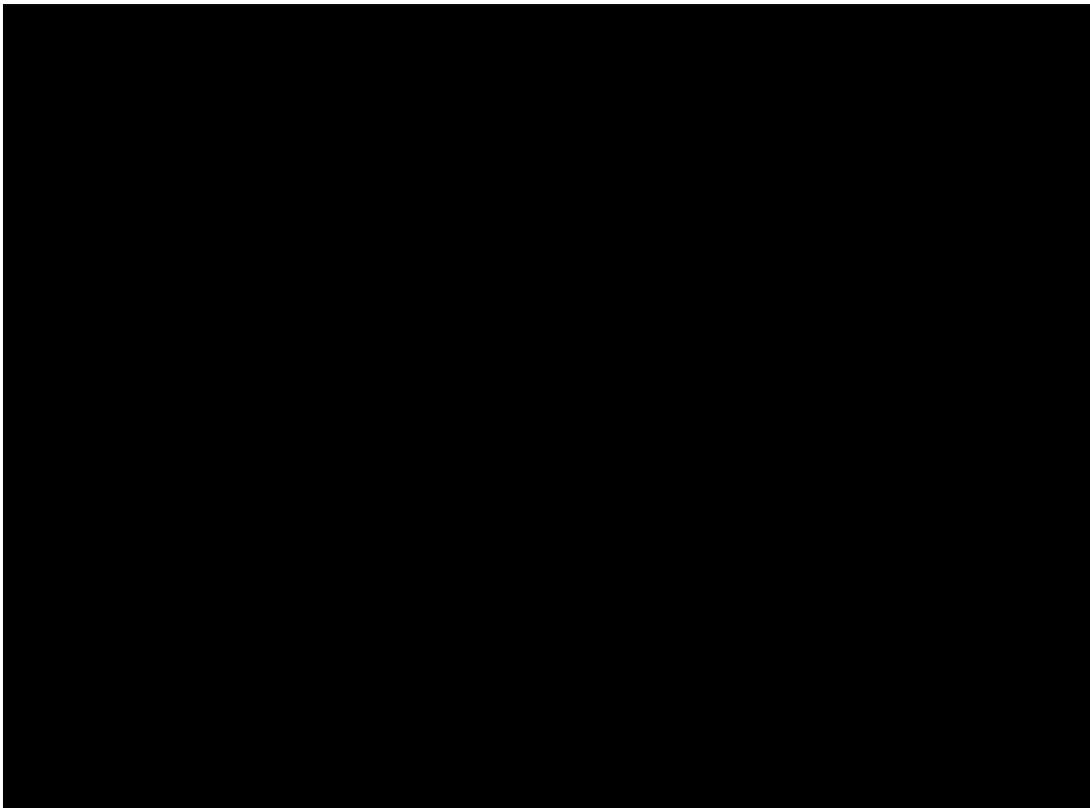
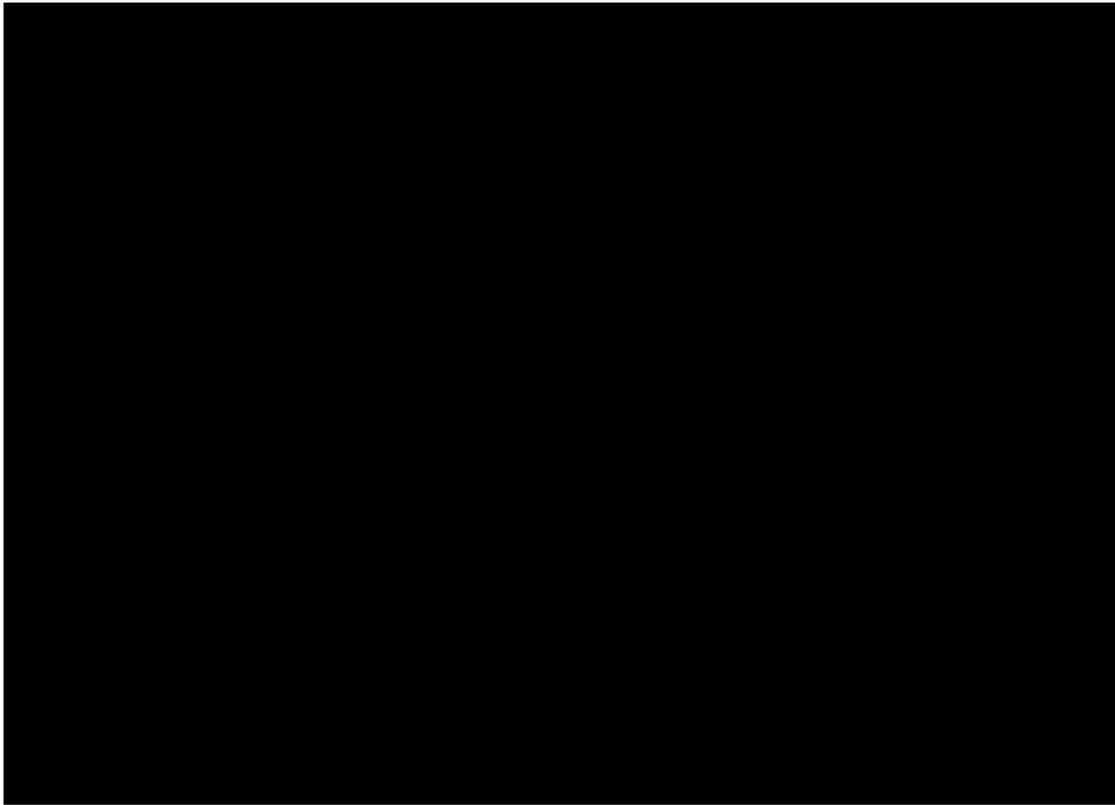


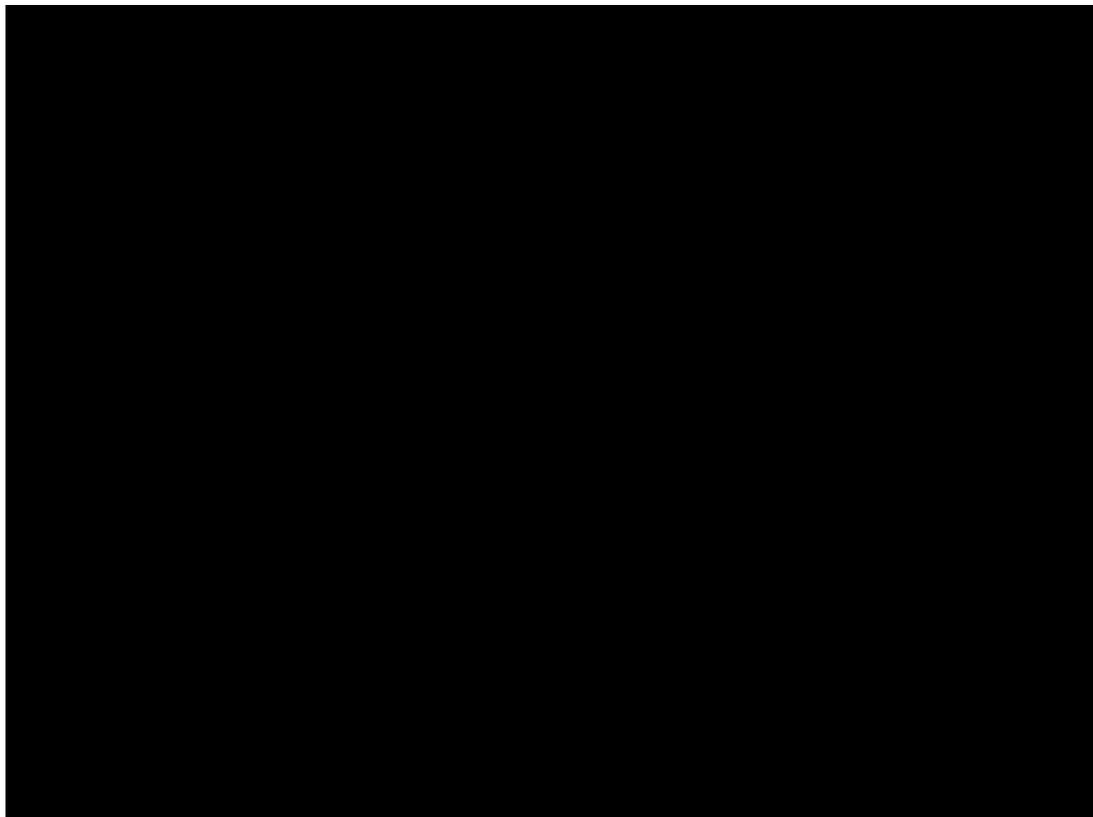
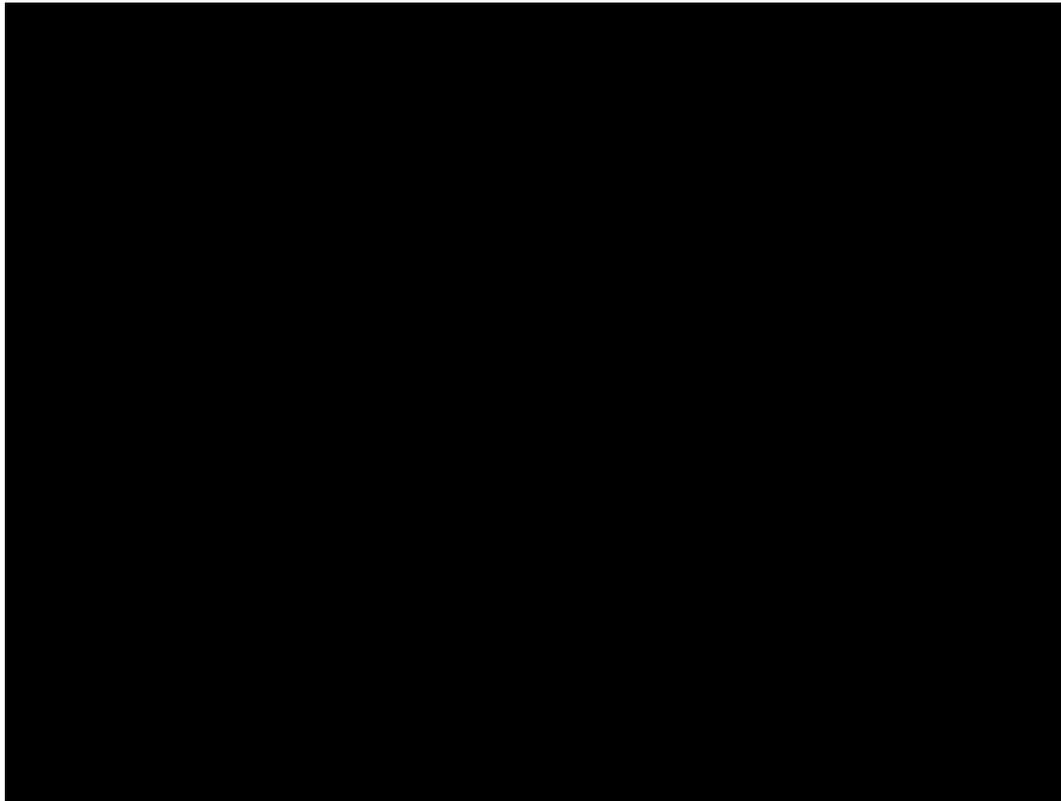


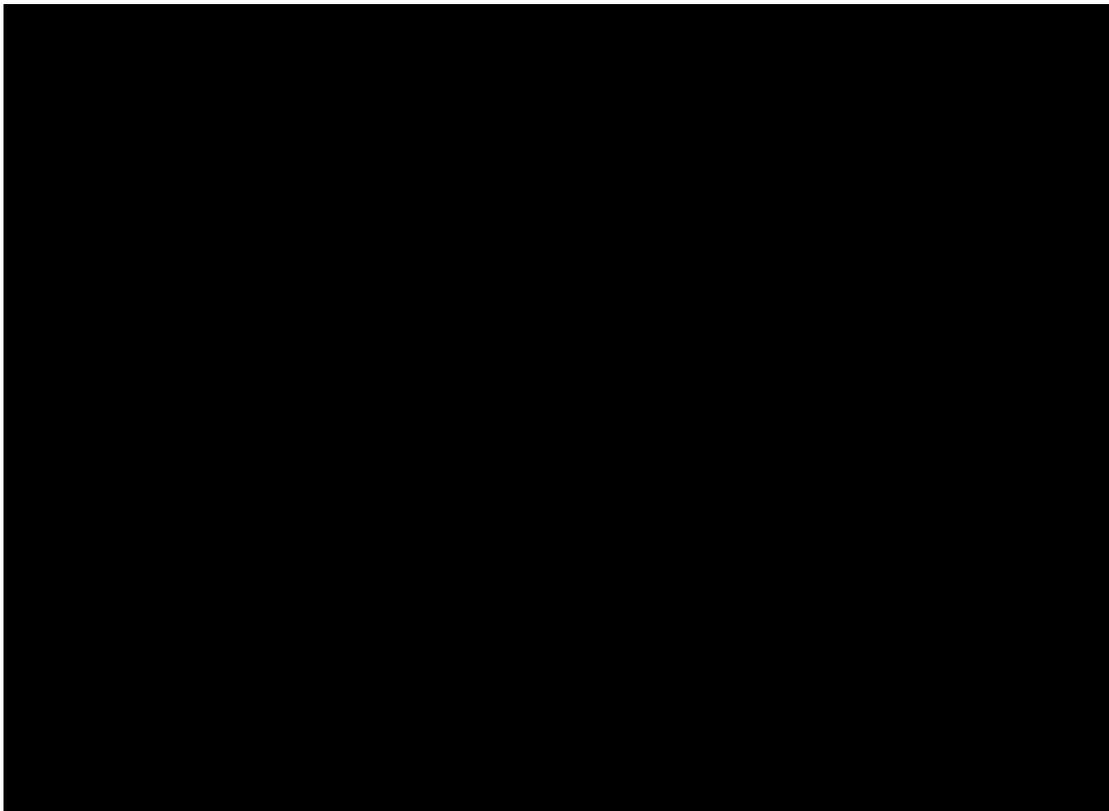
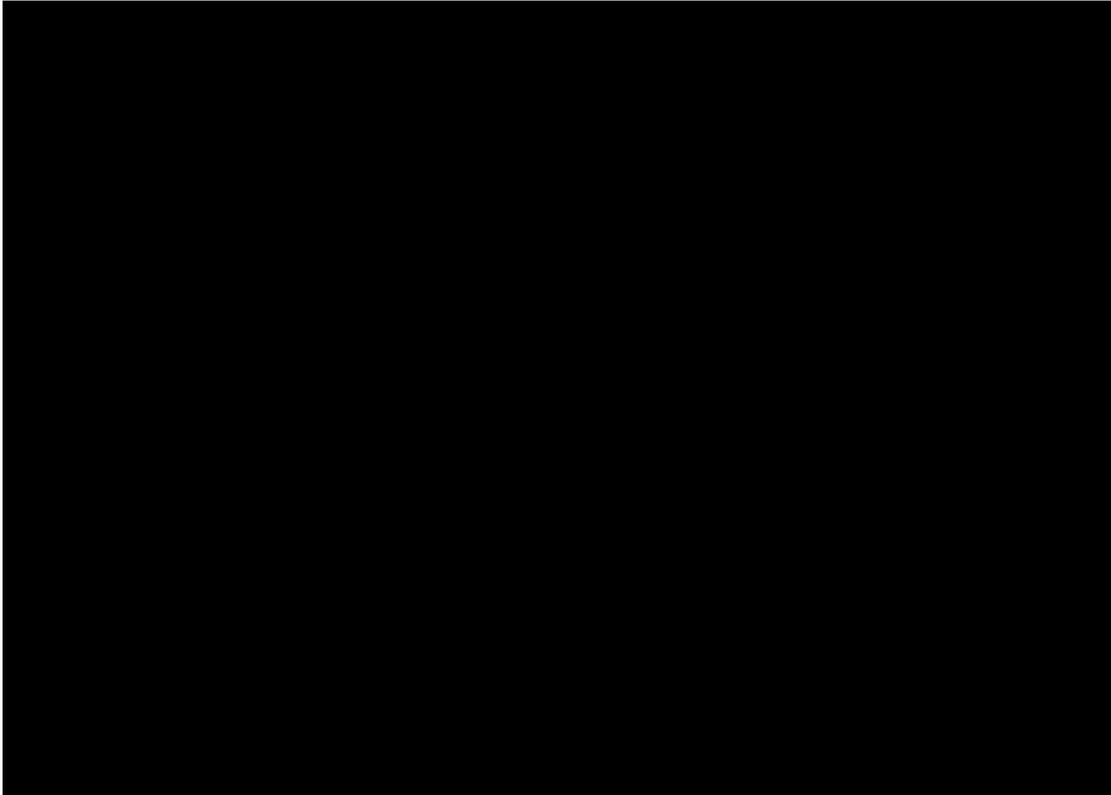


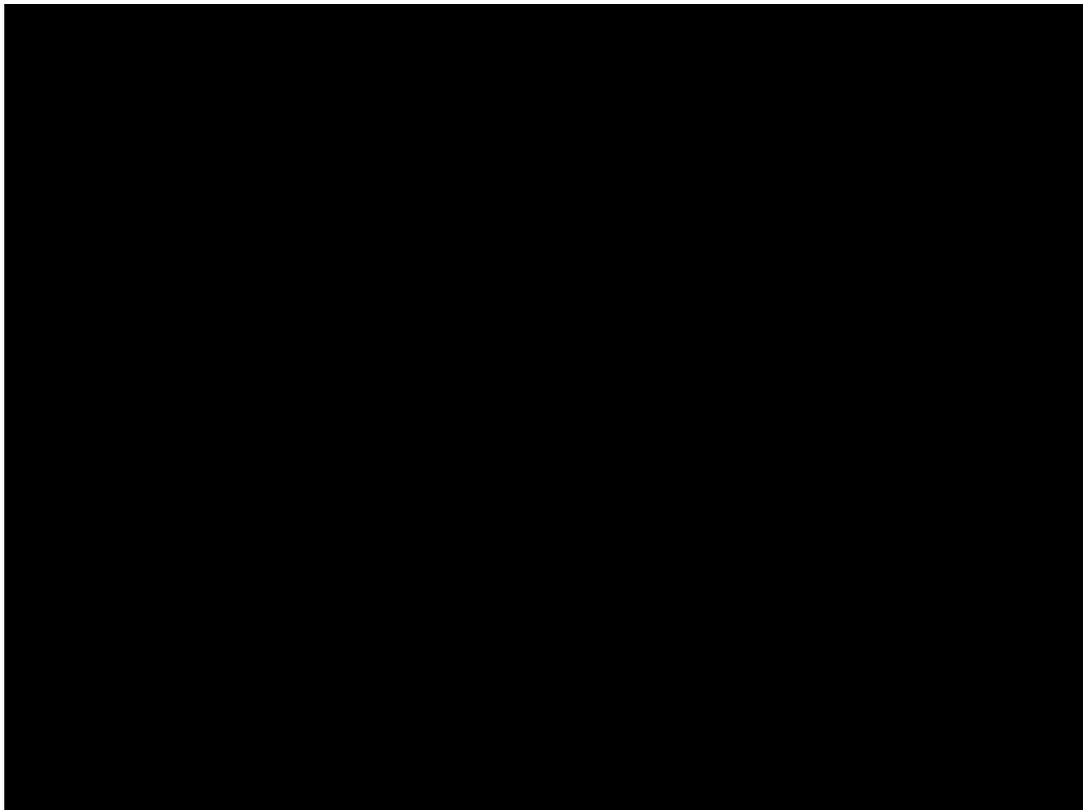
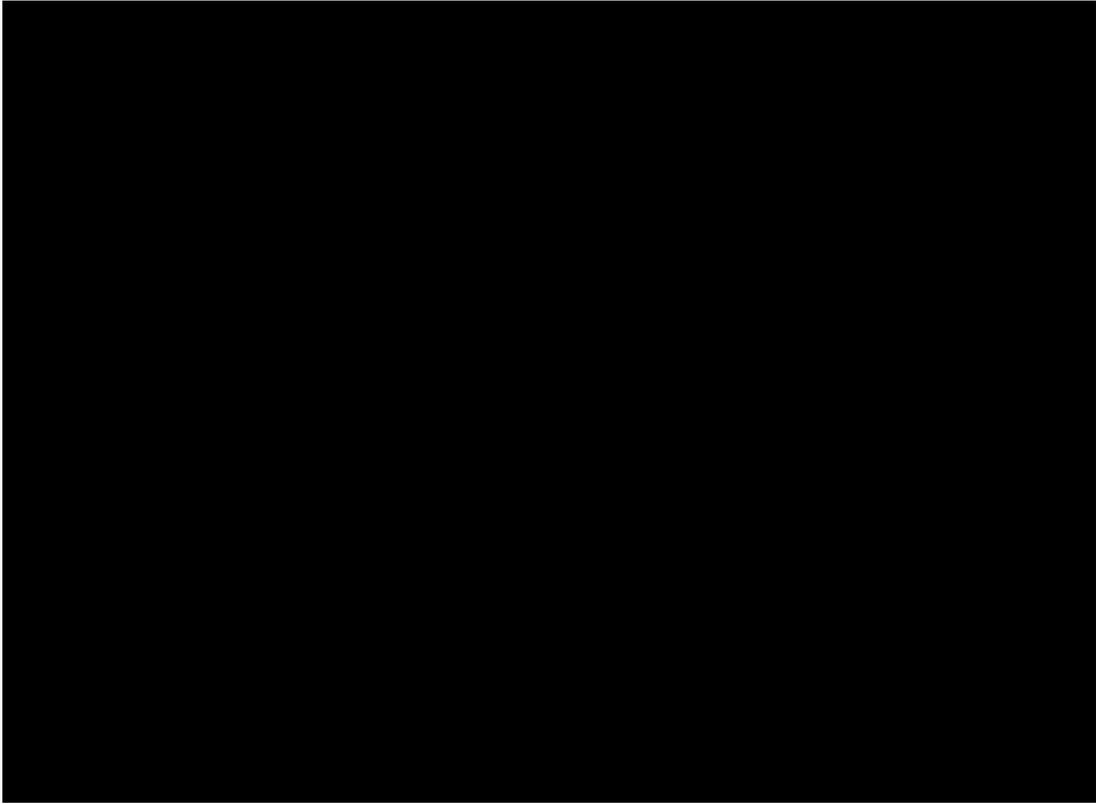












Appendix C

NATCEM 35 Data Sheet



NATCEM 35

Description

NATCEM 35 is a fast setting and fast curing mortar with a rapid strength gain that is resistant to chloride penetration, consisting of a blend of NATCEM Reg.31 Cement Binder, specially selected dried graded aggregates all passing a 2mm sieve and retarders.

Uses

- Waterproof renders
- Work in and around sewers
- Industrial floor repairs
- Work in food factories
- Concrete repair
- Work in and around the sea
- Animal sheds and silage pits
- Garage pits
- Basement tanking
- Farm yards and cess pits
- Pipe joints and benching
- Sealing garage pits
- Fast general repairs and construction work
- Work wherever pollution or chemical attack is likely
- Overhead and horizontally

- Setting holding down bolts
- Floor screeds
- Bedding blocks
- Stone and bricks
- In contact with potable water
- Fine moulding.

Properties

- Fast setting
- Excellent adhesion
- Low shrinkage
- Low modulus of elasticity makes it very effective on poor or friable substrates
- Excellent resistance to pure water and sulphated water
- Excellent resistance to aggressive chemicals
- Very good cohesion and mixing
- Fine compact surface
- No curing necessary. It can be coated, covered or painted as soon as setting is complete
- Can be used in wet conditions
- Can be used under water
- High Strength
- Low carbon dioxide permeability
- Low water permeability.



NATCEM 35

Method of use

Preparing the surface

Do not use on frozen or over heated substrates (Outside the range of 0°C-30°C). Prepare the surface in advance to provide an adequate key. On glazed brickwork the joints should be raked out and the surface bush hammered to form a key. The surface to which the NATCEM 35 is applied should be clean, free from dust and thoroughly dampened. Where necessary steel or aluminium mesh can be used. Ensure that a 10mm minimum thickness of material is obtained.

Priming

There is no need to prime any reinforcement, but if priming is preferred, any conventional system may be used.

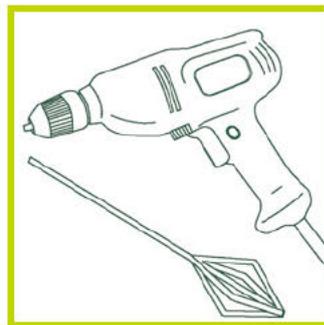
Application

Mixing

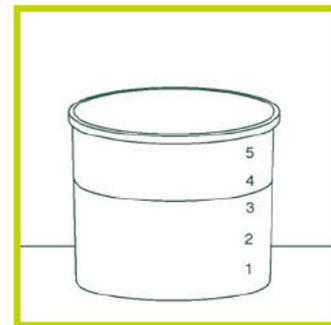
For optimum results, mix using conventional mixing machines. Always place the water in the mixer or mixing container and add the powder. Gradually add the NATCEM 35 to no more than 3.6 litres of clean water per bag whilst continuously mixing the material. If one bag or less is to be used the NATCEM 35 can be mixed with a rose bud type paddle attached to an electric drill (900rpm, 1000w). Mix vigorously for at least 2 minutes after adding all the mixture to

the water. NATCEM 35 is designed to give a fluid mix but this only develops after sufficient mixing. The mix will appear dry at first. Continue mixing until fluidity develops. If greater fluidity is required, more water up to a total of 4 litres may be used. Exceeding this ratio will lead to lower strength, longer setting time and the risk of surface cracking appearing. In cold weather the set can be accelerated using warm water, likewise in hot weather cold water can be used to slow down the set.

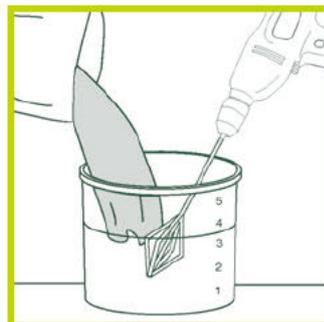
One bag



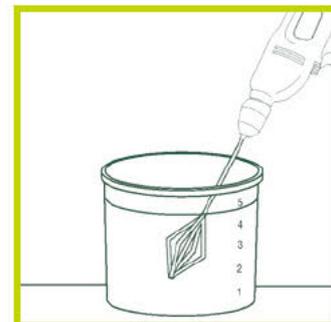
Rose bud paddle in electric drill 900rpm 1000w.



Place 3.6 litres of water into a container.



Add the Natcem 35 to water mixing all the time.



After the NATCEM 35 has been added mix for at least 2 minutes.

General

After mixing, apply the material as quickly as possible after mixing using traditional tools. A 10mm minimum thickness of the material is always necessary. Do not apply additional water to the surface during finishing as this may cause surface cracking. Once setting has started DO NOT attempt to remix or to smooth the surface. This will cause the mechanical properties, in particular strength and adhesion to be lost.

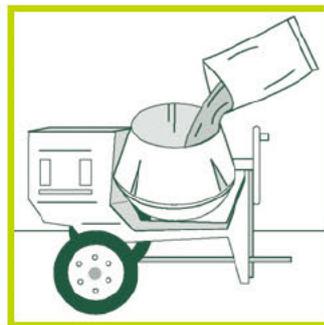
Tanking

Prepare the walls and floor which are to be treated by removing all paint and surface coatings. Cut a chase a minimum of 10mm deep by 10mm wide at all internal angles of the wall to wall and wall to floor joints, then fill with NATCEM 35 as the work proceeds. Form fixing points by cutting out an area at least three times the diameter and one and a half the length of the fixing, filling with the NATCEM 35 as work proceeds but clearly marking the position. Well dampen the surface with water but ensuring no standing water. Mix the NATCEM 35, well dampen the surface again with water, carry out the rendering of the walls using standard and accepted techniques ensuring at all times a minimum thickness of 10mm. Protect against direct sunlight or wind until the setting has completed. Once the NATCEM 35 has set, allow at least 1 hour before applying any surface coatings or covering to the walls or to the floors.

More than one bag



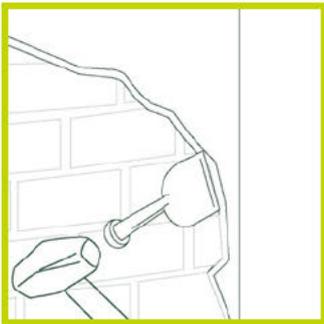
Add water to the mixer at a ratio of 3.6 litres per bag of NATCEM 35.



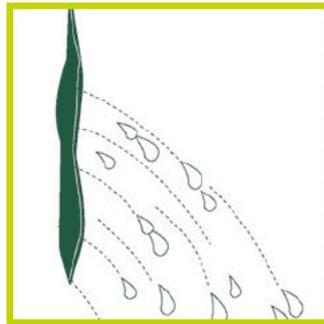
Gradually add the NATCEM 35 to the mixer.



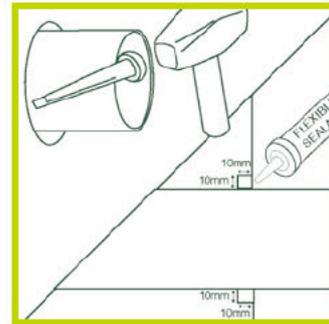
After adding all the NATCEM 35 mix continuously for at least 2 minutes at medium speed.



Prepare surface, remove paint, coatings, renders and plaster.



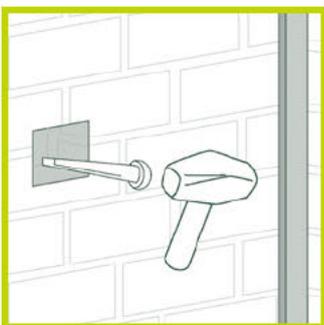
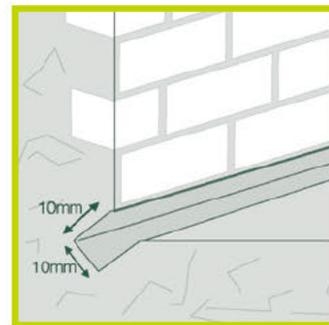
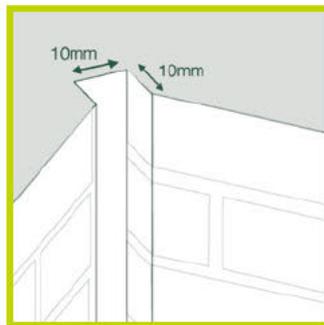
Stop any running water with NATCEM Waterstop. (See separate leaflet)



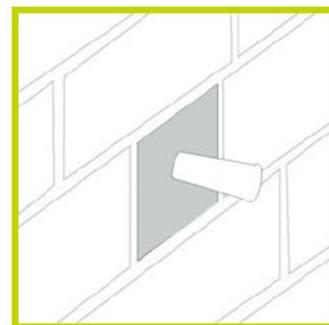
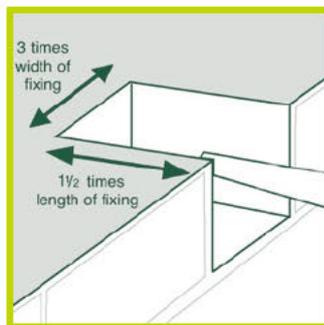
Cut a rebate around any pipe or cable and fill with sealant to form flexible seal around pipe or cable.



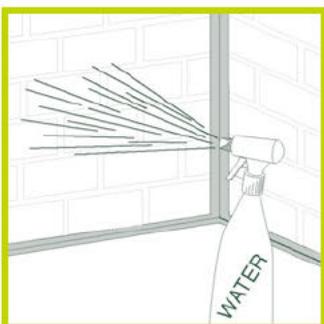
Form chase at wall to floor and all internal wall angles minimum 10mm x 10mm.



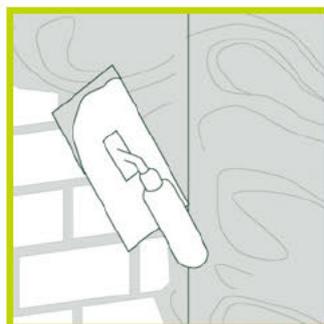
Cut out for fixing point.



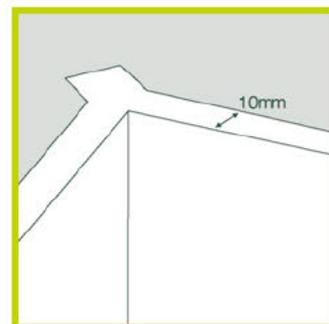
Fill fixing points and clearly mark.



Well dampen surface with water ensuring no standing water.



Apply material to wall.



Ensure at all times a 10mm minimum thickness.

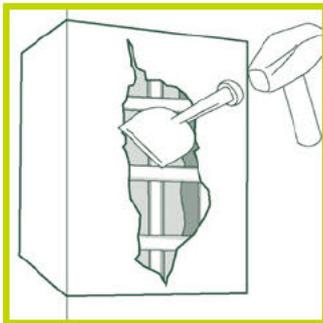
NATCEM 35 is a fast setting and fast curing mortar with a rapid strength gain that is resistant to chloride penetration, consisting of a blend of NATCEM Reg.31 Approved Cement Binder, specially selected dried graded aggregates all passing a 2mm sieve and retarders.

Concrete repairs

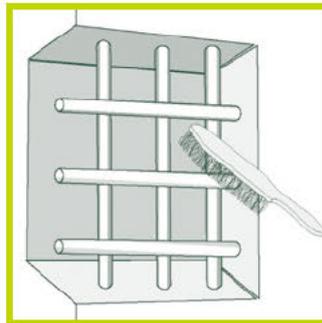
Remove all loose material from the concrete and the reinforcement. It is only necessary to remove the loose rust from the reinforcement. Prepare the surface as described previously. Fix any necessary replacement

reinforcement and formwork. Well dampen the surface with water ensuring there is no standing water. Mix the material, dampen the surface again and then apply the NATCEM 35 as previously recommended ensuring that the NATCEM 35 is worked around the

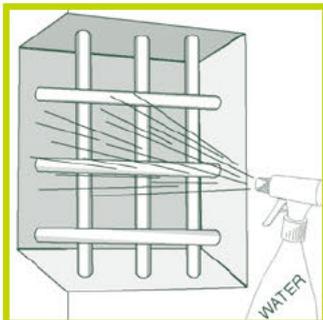
reinforcement. Ensure a minimum thickness of material of 10mm at all times. Protect the surface from direct sunlight or wind until setting has completed. Once the NATCEM 35 has set allow at least 1 hour before applying any surface coatings or covering.



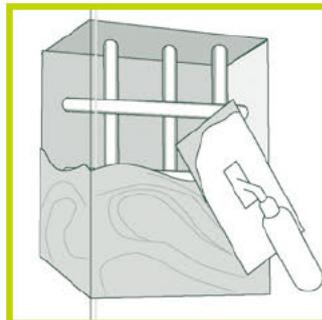
Cut back loose and spalling concrete a minimum depth of 10 mm.



Wire brush any reinforcement to remove any loose rust.



Well dampen the concrete with water ensuring no standing water.



Mix NATCEM 35 as instructed and place the mortar, ensuring at all times a minimum thickness of 10mm.

Setting times

NATCEM 35 is designed to commence setting at 35 minutes and finish setting at 40 mins at 20°C. In winter NATCEM 35 can be used down to 0°C. The set will be slower but can be accelerated by using warm water. In very hot temperatures the set will be faster and can be slowed by using cold water.

Surface Coating Natcem35

When applying finishing plaster to NATCEM 35 we would recommend using Thistle Board-Finish Plaster and not Thistle Multi-Finish

Cleaning

Clean all tools with water immediately after use.

Storage

NATCEM 35 is packaged in a polythene inner bag with a re-sealable tie within a stitch sealed woven polypropylene outer bag that should be stored in dry conditions and will last for at least twelve months.

Yield

Generally 1 x 25kg bag of NATCEM 35 mixed with 3.6 litres of water will produce 10 litres of finished mortar.

How to specify

NATCEM 35 shall be mixed and applied to prepared surfaces all strictly in accordance with the manufacturers instructions.

Precautions

We strongly recommend the use of GLOVES, GOGGLES and MASK. Full details are given on a separate sheet.

Approved for use in public water supplies. Reg.31 Approved

Issue no. 26th June 2017

Setting time & strength gain

Start Set	35 Min	at 20°C
End Set	40 Min	at 20°C
	Flexible Strength (Mpa)	Compressive Strength (Mpa)
1 Hour	2.2	9
3 Hours	2.5	16
24 Hours	3	21
7 Days	4.8	29
28 Days	7	50
Strength continues to develop thereafter.		

Conforms with the requirements of EN1504-3 CLASS R4



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